U. S. DEPARTMENT OF AGRICULTURE

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OF THE

MOUNT WEATHER OBSERVATORY

VOLUME II.

PREPARED UNDER THE DIRECTION OF
WILLIS L. MOORE, D. Sc., LL. D.
CHIEF U. S. WEATHER BUREAU

WASHINGTON
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CIRCULAR LETTER TO TECHNICAL METEOROLOGISTS.

[The following is the text of a letter addressed by the Chief of Bureau to meteorologists and is published for the information of all who are willing to contribute to the pages of this Bulletin.]

The successive numbers of the Bulletin of the Mount Weather Observatory have thus far been filled principally by contributions from members of the scientific staff of the U. S. Weather Bureau, but it is not desired to impose such limitation on it. I am authorized to say that the scope of the Bulletin will cover the technical discussion of any problem bearing on the physics of the earth's atmosphere. All students of meteorology are cordially invited to submit for publication therein such researches, observations, or comments as have a bearing on any phase of the physics of the atmosphere. Communications in the English language are specifically desired; those made in other languages will be translated subject to the approval of the authors. Authors of memoirs too long for publication in this Bulletin are respectfully invited to communicate authoritative summaries or abstracts. It is desired to make this periodical as useful among English-speaking meteorologists as the corresponding bulletins, journals, and official publications in other languages have become to our colleagues of other nations.

In accordance with a recent announcement in the Monthly Weather Review, that publication will hereafter be confined to climatological data and the relations between climatology and practical problems in engineering, hygienics, or agriculture. On the other hand, the Bulletin of the Mount Weather Observatory will be specifically devoted to a field not now covered by any American journal, i. e., research and progress in aerology and all that higher physical meteorology to which we must look for future improvements in our forecasts of daily and seasonal weather.

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CORRIGENDA.

Page 42, in table for August 17, 1908, column 1, for "a. m." read "p. m."

Page 48, in table for September 8, 1908, column 1, for "p. m." read "a. m."

Page 55, omit the six lines at bottom of page 55 and the next seven lines at top of page 56 and substitute the following: "of propagation of the beam and parallel to the plane of vibration of the ray scattered. Suppose the vibrations in a

ray propagated in the direction of *IO* to be parallel to *OP;* the scattering will be symmetrical about *OP* as an axis, being zero in the direction of *OP*, and reaching a maximum of 90° from it. Similarly any other ray propagated in the direction *IO* will be scattered symmetrically about an axis perpendicular to *IO* and parallel to its path of vibration. The vibrations of any one of these scattered rays will be in a plane containing the corresponding axis of symmetry and the ray itself. But since in a beam of unpolarized light the vibrations occur in all planes that pass through the direction of propagation, there will in this case result a symmetrical scattering about *IO* as an axis, with complete polarization in the plane *APB*, diminishing to zero polarization 90° from this plane."

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Vol. II **BULLETIN** Part I

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VERTICAL TEMPERATURE GRADIENTS OF THE ATMOSPHERE, ESPECIALLY IN THE REGION OF THE UPPER INVERSION.

By W. J. Humphreys.

OBSERVATION.

General Statement.

The vertical temperature gradients of the atmosphere, the condition and distribution of its moisture, the direction and speed of the winds, and other upper-air phenomena have long been objects of investigation. Meteorological stations located on hills and on plains, on mountain tops and in valleys, especially when near together, have furnished and continue to furnish much information both valuable and interesting. And for many years this has been supplemented in part by studies of the heights, of the forms, and of the velocities of clouds, and to some extent by records obtained in manned balloons, and still further by the aid of registering instruments sent up in kites. But all the information obtained in these several ways, tho of the greatest value to the science of meteorology and to the art of forecasting, has thus far been limited by the upper level of the cirrus clouds. Within this region, however, observations soon made it certain that thru a considerable distance next beyond some three thousand meters above the surface of the earth, changes with altitude are more or less uniform; that in general the moisture constantly decreases; that the winds increase in velocity, and that the temperature fall approaches the adiabatic rate.

The conditions at higher altitudes could only be surmised, but many, by the uncertain process of extrapolation, assumed that the temperature must continue to decrease at about this same rate far out, and until it was as low as adiabatic expansion could make it; that the moisture content must gradually decrease to zero, and that the winds in middle latitudes must remain easterly with speeds increasing with elevation. However the splendid work with sounding balloons by Teisserenc de Bort,[1] by Assmann,[2] by Hoormann,[3] by Rotch,[4] by Peta-

[1] C. R. v. 134, p. 987; v. 138, p. 42; v. 145, p. 149; Quarterly Journal, Royal Meteorological Society, July, 1908, p. 189; also many numbers, Veröffentlichungen.

[2] Veröffentlichungen der Interna. Kom. für Wis. Luftschiffahrt.

[3] Ciel et Terre, 1907–08; and Veröffentlichungen.

[4] Nature, 78, p. 7, 1908.

vel,[5] and by many others, has shown these assumptions to be radically wrong.

BALLOON RECORDS.

During the past ten years hundreds of sounding balloons, equipped with suitable registering apparatus, have been sent up under widely different conditions to various heights; many to 15 kilometers, some to 20 kilometers, and a few to even higher levels. The records represent flights by day and by night made in all sorts of weather and in every season of the year; flights over continental, island, and ocean regions; and flights at different latitudes from the Tropics to beyond the Arctic Circle; and besides the apparatus used has been by several makers and of different design. In this way disturbances due to location and to storm influence have been detected and systematic instrumental errors largely avoided. But the results of all the observations are in general accord, and show that the explored portion of the atmosphere consists of three more or less distinct regions.

I. The region of terrestrial disturbance, extending from the ground to an elevation of roughly 3,000 meters above its surface, in which the temperature gradient usually is very irregular and often locally reversed. This is also the principal region of cloud formation and of precipitation.

II. The region of uniform changes, lying roughly between the upper limits of I and the 10,000-meter level above the sea, in which the temperature gradient, nearly constant, approaches the adiabatic. This region is comparatively free from condensation and precipitation, since it lies above the average nimbus cloud while the cirri float in only its topmost portion. At times it is the seat of vertical convections of varying extents and intensities, but its normal condition is one of stability as shown by its usual freedom from clouds, and as necessitated by the negative departure, numerical decrease, of its temperature gradient from the adiabetic.

III. The region of permanent inversion, or all that explored portion above the 10,000-meter level or thereabouts. Here the temperature gradient is small and usually positive, and vertical convection therefore always impossible.

In the region of terrestrial disturbance, that is, in the lower or denser portions of the atmosphere, the winds are irregular, and commonly differ in both speed and direction above and below any, other than a mere surface, inversion. In all essentials they are chiefly determined by the locations and intensities of barometric highs and lows.

[5] Nature, 78, p. 56, 1908.

The highs and the lows continue to play an important part even far up in the region of uniform changes, but are less and less effective as the elevation is increased. In the upper portion of this region the great planetary circulation mainly prevails as shown by the movements of the cirrus clouds which are near its upper limit. It is known, too, from the drifting of balloons and from observations on clouds that in this region the wind moves faster and faster with increase in elevation, and easterly in extra-tropical countries. Above the inversion level the velocities of the winds are much less[6] than they are immediately below it. On passing up from the one region into the other this velocity is usually found to drop by from 25 to 80 per cent, and apparently the directions in the two places have but little interdependence. Besides the air above the place of inversion seems always to be excessively dry[7] no matter what the humidity may be at lower levels.

The height, generally sharply defined, of the place where the upper inversion begins, like its temperature, is a function of season, of latitude, of barometric pressure, and probably of still other conditions. It is high up in a well-formed "high" and correspondingly low in a "low." It is at greater elevations and higher temperatures in summer than in winter, and descends with increase of latitude from the Tropics to the polar regions. The higher it is found above the earth, season and other things being equal, the lower in general is its temperature, and conversely the lower it lies, under similar conditions, the warmer it is.

We therefore have two distinct atmospheres that intermingle but slightly; a lower or inner turbulent one, with a large negative temperature gradient, and an upper or outer one with a small positive gradient, floating on the first like oil on water. The lower contains from two-thirds to three-fourths of the entire mass of such gases of the air as oxygen, nitrogen, and all the members, except helium, presumably, of the argon family; a still greater proportion of the carbon dioxide, and nearly all the water vapor. It is warm in its lowest portion, but cools, irregularly at first then rapidly and nearly regularly, with increasing elevation to a minimum of from —40° C. to —70° C. The upper atmosphere contains extremely little water vapor, and its temperature rises sometimes abruptly at the start and then slowly, but usually slowly all the way with elevation from the place of inversion to an unknown temperature at a height not yet reached. Occasional

[6] Bassus, Beiträge zur Phys. der freien Atmos. v. 2, p. 92, 1908.
[7] Kleinschmidt, Beiträge zur Phys. der freien Atmos. v. 2, p. 205, 1908.

observations indicate an isothermal condition, and for this reason the outer atmosphere is often called the "isothermal layer," and a few

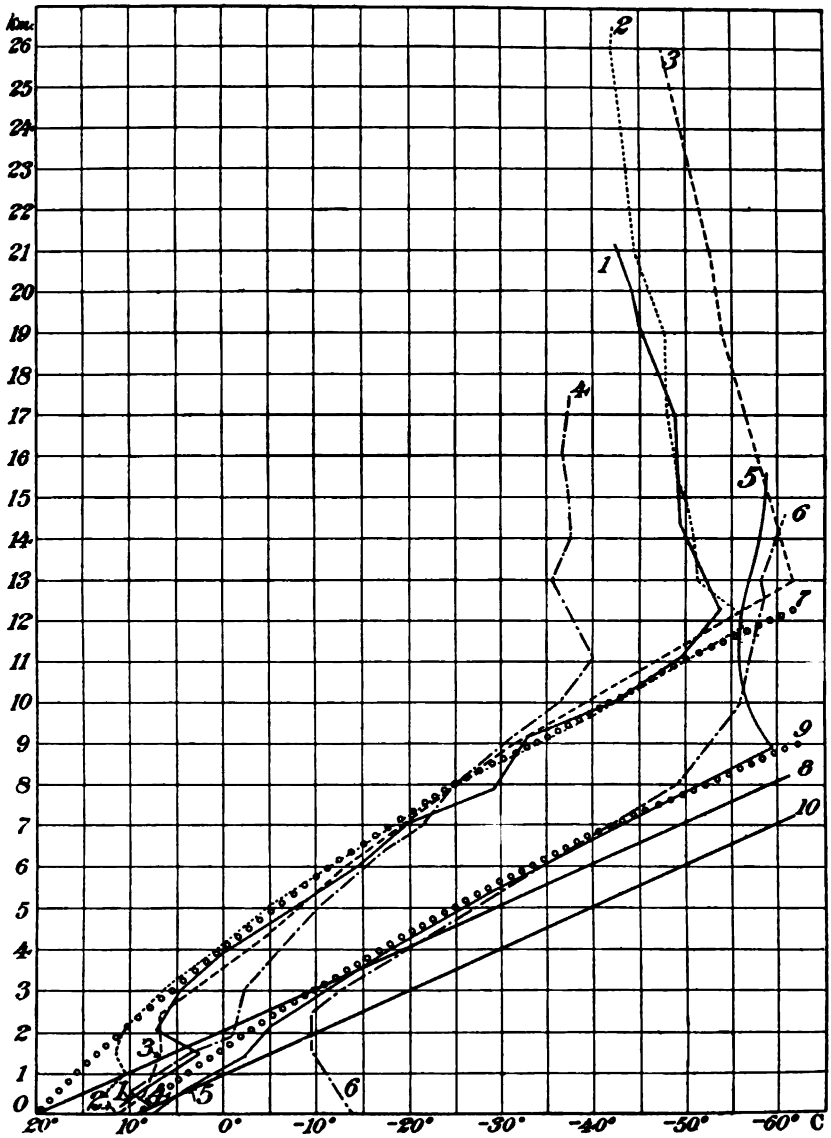

FIG. 1.

observations have shown even a slow cooling with elevation, but both these conditions are unusual.

The region above the upper inversion can not appreciably be penetrated by convection currents from the air below, since this would cause a cooling by expansion of the rising mass to a temperature lower than that of the surrounding medium, so that under the same pressure or at the same level its density would be greater than that of the adjacent air; and therefore all storms, all condensation, all abnormal and irregular moisture distribution, and virtually all dust, except that of meteors and of violent volcanic eruptions, are limited to the lower atmosphere. The upper atmosphere, floating on the lower, will rise and fall as a whole with the latter, with however more or less mixing of the contiguous portions of the two. Upward currents of air, when they reach the inversion surface, since, as explained, they can not rise any farther, are forced to spread out under it somewhat as warm air in a room spreads out next the ceiling; and doubtless this air carries with it the moisture for the highest cirrus clouds because, like the inversion layer, they approach nearer the earth in colder regions, nearer in winter than in summer, and are highest toward the end of a clear, warm spell of weather.

Much of the above is well illustrated by the temperature gradient curves of fig. 1, which is copied, with slight additions, i. e., curves 7 to 10, inclusive, from the Annuaire Meteorologique pour, 1908, Observatoire Royal de Belgique.

The flights giving these curves were made from Uccle, near Brussels, only 100 meters above sea-level, and with a number of others made at other times, for these include all that were made within the dates given, have been reported in detail by Hoormann, in Ciel et Terre.

The following table contains some of the more important data in connection with these ascensions. The temperature gradient is for the region of uniform changes. The flight of July 25 lasted two and a half hours; the others about two hours each.

No. of curve.	Date.	Hour of starting.	Condition of sky.	Barometer at station.	Weather.	$\frac{\Delta t}{100\ m.}$ Region of uniform change.
				Mm.		°*C*
1	July 24, 1907	7 a. m..	Covered. Strato and fracto-cum.	751.5	Neutral.....	0.68
2	July 25, 1907	7 a. m...........	Four-tenths cirrus..	751.0	Neutral.....	0.70
3	Sept. 5, 1907	7 a. m..........	Covered. Alto-strat. and fracto-cum.	754.0	Neutral.....	0.66
4	Oct. 3, 1907	7 a. m..........	Covered. Stratus ...	744.0	Cyclonic....	0.50
5	Dec. 12, 1907	After sundown..	Covered. ?	740.0	Cyclonic....	0.83
6	Jan. 3, 1908	7 a. m..........	Serene.............	760.0	Anticyclonic	0.71

Curve 8, a straight line, gives the adiabatic gradient for dry air, and curve 7 gives the temperature gradient for saturated air, both starting at sea-level with a temperature of 20° C. Curves 9 and 10 are the same as 7 and 8, respectively, except that the initial temperature is assumed to be 9° C. Curves 1 to 3, inclusive, give a summer group, while 5 and 6 represent winter gradients. It will be noticed at once, and this is generally true, that the winter curves have a slope intermeditate between the dry adiabatic and those of summer, and that the temperature gradient is distinctly less in summer than it is in winter. It will also be noticed that the upper inversion is located higher in summer than in winter. That, of the summer gradients, No. 3, had the highest barometer and inverted at the greatest altitude, and that a cyclonic condition, or low barometer, lowers the place of inversion. Further, that the higher the inversion, at any season, the less its temperature; and conversely. The place of inversion, usually, and in all these, except No. 6, is rather sharply defined.

THEORY.

IRREGULARITIES IN TEMPERATURE GRADIENT OF THE LOWER ATMOSPHERE.

The thermal irregularities and local inversions of the lower atmosphere are caused by wide temperature changes in the surface of the earth, by the over and by the under running of warm and of cold masses of air, and by the action of cloud layers in changing the position of insolation from the earth and from the denser portions of the atmosphere to higher levels.

MORNING INVERSIONS.

The inversion so commonly found in the early morning is due to the fact that the surface of the earth radiates more freely than does the atmosphere at the same temperature, and that therefore of nights, especially when the sky is at all clear, it cools correspondingly lower, and also cools the atmosphere for some distance above it to an extent depending largely upon the humidity, degree of cloudiness, and wind velocity.

The more humid the air the less the depth to which earth radiation can directly penetrate, and, therefore, the more slowly, because of counter radiation, it gets away. Clouds check the loss of heat mainly by reflection; while the winds by mixing the air of different levels prevent excessive cooling at the surface.

The effects of this nocturnal cooling are well shown by the curves, as above explained. Flight No. 5, made just after sundown, of course shows no such disturbance.

DEPARTURE OF GRADIENT FROM THE DRY ADIABATIC.

Altho the atmosphere is constantly in a state of more or less turmoil, its average temperature gradient, even in the region of uniform changes where this is greatest, is less than the adiabatic of dry air; due partly to the heat it absorbs in the form of earth and of solar radiations—an amount which during the day is in excess of the corresponding loss—but chiefly to the fact that the air is not dry, and that it therefore receives much heat, as it rises, from condensation of the moisture it contains. This liberated sensible heat by all processes of distribution, conduction, convection, and radiation extends to and warms the colder masses above, and decreases by counter radiation the loss of heat from lower levels. The temperature gradients are modified most in the lower atmosphere where the average percentage of saturation is greatest, and where, because of the temperature, its water capacity is large.

Curves 7 and 9 show how closely the actual normal gradients follow saturation paths, even tho actual saturation seldom exists except in the midst of clouds, and how widely they depart from lines 8 and 10, that correspond to dry adiabatic expansion.

SEASONAL DIFFERENCES IN TEMPERATURE GRADIENT.

The conditions that determine the departure of ordinary air gradients from those of dry air, insolation and moisture content, are more pronounced in summer than in winter, and therefore summer gradients should differ from winter ones in being still farther removed, as they actually are, from the adiabatic curve of dry air.

This effect is best seen in the region of uniform changes, where, according to observations, the ratio of summer to winter gradients averages about 9 to 10. Local and temporary disturbances may easily mask it near the surface of the earth.

STORM GRADIENTS.

A summer cyclone furnishes the extreme of departure from dry air conditions, and therefore also yields the extreme gradient departure from the dry adiabatic, as illustrated by curve 4. It even sets free much heat in the rainy sections by condensation of moisture drawn in by the winds from distant regions. Two centimeters of rain, for in-

stance, will free as much heat as the surface of the earth would receive in sixteen clear summer noon hours of sunshine, and practically all this heat goes to the higher atmosphere, as the lower levels and the ground are not warmed by the rainfall, but rather cooled by its evaporation, and because of the lower temperature it had when it left the clouds, and often by the under running of masses of cold air.

The upper and the lower parts of curve 4 illustrate these effects.

CAUSE OF THE UPPER INVERSION.

Several attempts have been made to account for the upper inversion. Probably the earliest is that of Assmann,[8] who suggested that the warm air above the inversion level is a part of the world circulation from the equator to the poles.

Several objections can be found to this theory, among them the fact that the level of the inversion surface and the temperature of the air above it are functions of the conditions of the lower atmosphere; and that it is not supported by the directions of the warm upper air currents, which often are from northerly[9] points, and are in fact irregular[10] both as to direction and as to speed.

Nimführ[11] made a slight modification of Assmann's theory when he suggested that the isothermal layer is due to a downward component of the air, together with its movement from the south. But the above objections also apply to this theory.

Fenyi[12] makes the plausible suggestion that it is due to the absorption in the outer atmosphere of an unknown amount of ultraviolet light. But observations by Abbot and Fowle[13] indicate that the absorbed ultraviolet portion of the sun's energy is of the order of only 2 per cent or less of the total insolation; and therefore even if there was no loss by radiation or otherwise, it would in twelve hours heat the air of the isothermal layer by less than half a degree, an amount insufficient to account for the observed temperatures.

Trabert[14] holds that possibly the vertical temperature gradient is less above oceans than above continents, and that therefore the upper inversion may be due to this relatively warm air as it sweeps over the land. But it is not clear how this can account for the increase of

[8] Sitz. der Kön. Preus. Akad, der Wis. v. 1, p. 495, 1902.
[9] Hergesell, Beiträge zur Phys. der freien Atmos. v. 1, p. 143, 1905.
[10] Basus. Beiträge zur Phys. der freien Atmos. v. 2, p. 92, 1906.
[11] Metl. Zeit. v. 23, p. 245, 1906.
[12] Metl. Zeit. v. 24, p. 355, 1907.
[13] Annals Astrophys. Obser. Smithsonian Instit. v. 2, p. 56.
[14] Met. Zeit. v. 24, p. 504 and 565, 1907.

temperature beyond the minimum layer, nor is it supported by the irregular directions of the winds in the upper region, and finally the inversion is as definitely found over the oceans themselves as anywhere else.

Very[15] ascribes the isothermal condition to the absorption of lines and bands of water vapor. A fatal objection to this theory, however, if the observations are correct, is the fact that the water vapor is not there to absorb.[16] Certainly there can be but little at an elevation of 26 kilometers, at which elevation the temperature is still increasing.

Teisserenc de Bort[17] has suggested that the "isothermal layer" is due to the fact that there is in this region but little vertical convection. It seems, however, more probable that the absence of convection is a result rather than the cause of this warm layer.

Gold[18] claims that an explanation of the existence of the "isothermal layer" must take into account the radiation of the atmosphere, and gives conclusions, which he says follow from certain assumptions as to its absorption, so suggestive as to make a fuller paper from him on this subject very desirable.

Assuming balloon observations correctly to represent conditions as they actually exist, it is interesting to find their physical basis, and to the practical meteorologist extremely important to do so, since the chief hope for improvement in forecasting rests upon an increase in our knowledge of the causes and of the effects of atmospheric phenomena. And since these involve the transfer and the transformation of energy, it is necessary first to determine the whence and the whither, as well as the amount and kind of this energy supply.

A little energy reaches the atmosphere by conduction from the heated interior of the earth; some from the omnipresent radioactive elements; a little as a result of meteoric bombardment; and possibly an additional small amount thru solar electrons, but the sum total from these and from similar sources is negligibly small. Even the combined radiations of all the stars, exclusive of the sun, is estimated to produce an effective space absolute temperature of only a few degrees centigrade; not less than two probably nor more than ten.

Hence the supply of energy to the earth is almost wholly of the radient form from the sun, and, neglecting trifling losses otherwise, equilibrium is maintained by a correspondingly intense reflection and

[15] Phil. Mg., Sept., 1908, p. 467-468.

[16] Kleinschmidt, Beiträge zur Phys. der freien Atmos. v. 2, p. 205, 1908.

[17] Nature, 78, p. 551, 1908.

[18] Nature, 78, p. 551, 552, 1908.

radiation from the earth to space. The causes, therefore, of many atmospheric conditions, among them the existence of the upper inversion, are to be found in the phenomena of absorption and of radiation as they pertain to the substances concerned and to the particular limits of wave-length and of temperature involved.

Solar energy, excepting a small amount, as it reaches the earth's atmosphere, is confined to wave-lengths ranging from 2.5μ down, with the maximum intensity somewhere between 0.4μ and 0.5μ. The extent to which this energy is absorbed by the gasses surrounding the earth is not an easy matter to determine, since it depends upon the wave-length, upon the kind of gas and its temperature, upon the amount of gas thru which it passes, or its partial pressure, and even upon the total[19] pressure to which it is subjected; nor is it certain that these are all the modifying conditions. Still, due mainly to the Astrophysical Observatory of the Smithsonian Institution, much is known about this problem.

On the violet side, as it reaches us, the energy curve is very steep, and vanishes for ordinary levels at about 0.3μ. It is also steep on the red side, so that roughly three-fourths of the total energy lies between 0.4μ and 1.1μ. The extreme ultraviolet portion of the insolation, of which there can be no reasonable doubt, is wholly absorbed by the outer dry portions of the atmosphere, as are also certain narrow regions, such as make up the oxygen lines in the red. And besides, a general, tho less and less, absorption extends to regions nearer and even into the visible spectrum.

Lower down in the atmosphere water vapor absorbs particular groups of wave-lengths amounting in all to from 5 to 10 or 12 per cent of the whole energy. The rest is absorbed or reflected by clouds, by dust, or by the surface of the earth. That portion, of course, of the reflected light which returns to space retains its original wave-lengths. The absorbed part of the energy, however, escapes as earth radiation of long wave-lengths, from 4μ to 20μ mainly, with the maximum intensity not far from 12μ. For all these water vapor, according to Rubens and Aschkinass,[20] has a large coefficient of absorption, and for a few of them so has carbon dioxide; so that radiation does not escape to any great extent directly from the earth, nor from the air or clouds of lower levels, but chiefly thru a step by step process, as each layer radiates to those above and these in turn more and more freely to space thru the remaining water-vapor and the outer dry

[19] Ångström, Arkiv för Matematik, Astronomi ock Fysik, V. 4, No. 30, 1908.

[20] Annal. d. Physik. 64, p. 598, 1898.

atmosphere, where the coefficient of absorption certainly is small.

Since the horizontal layers of the moisture may be regarded as absorbers of energy, and as radiators, it is easy in a general way to consider the action of a given layer in sending radiation to say a unit horizontal area at any position above or below it.

Let S be the unit area parallel to, but any distance from, a flat raditing surface of infinite extent, and let I be the radiation intensity of the plane, that is, the total upward radiation in all directions from a unit surface, divided by 2π, and let θ be the angle of incidence of a ray on this unit area. Then, in the absence of any absorption, the the total radiation normal to S is,

$$R = 2\pi I \int_0^{\frac{\pi}{2}} \sin\theta \cos\theta d\theta = \pi I.$$

Let now a uniformly absorbing layer of constant thickness t be placed parallel to the radiating plane, but between it and S. Then the length of that portion of any ray within this layer on its way to S is,

$$l = t \sec \theta.$$

If a is the coefficient of absorption, that is, in the case of normal radiation, the ratio of the energy absorbed by a layer of unit thickness to the incident energy, then the amount absorbed by a layer of thickness l is $1 - (1 - a)^l$, but when a is small and l not overly large this is approximately $la = at \sec\theta$; and therefore in this case,

$$R = 2\pi I \int_0^{\frac{\pi}{2}} \sin\theta \cos\theta d\theta - 2\pi I at \int_0^{\frac{\pi}{2}} \sin\theta d\theta = \pi I (1 - 2\,at).$$

These equations give the intensity of the radiation from the initial surface normal to A in terms of experimentally determinable quantities, and show that while it is a function of the absorbing layer it is, nevertheless, in each case independent of the distance from the radiating surface. The absorbed energy, however, is reradiated, so that the sum total of the outgoing energy is a constant.

Therefore above the plane of the upper inversion, that is, above the moisture of the atmosphere, or the region in which solar energy is mainly absorbed, the radiation normal to a horizontal area from any plane below is, neglecting the slight absorption of the dry air thru which it passes, approximately independent of its position, so long as

the distance above this plane is small in comparison with the radius of the earth, as of course that of every point so far reached really is. And, as explained above, when equilibrium is established the total radiation to this surface is independent of absorption.

In considering the temperatures in the region of the upper inversion the effects of earth radiations, λ_e, and of solar radiations, λ_s, will be examined separately, because the latter, besides being active only half the time, produce results other than heating alone, and therefore the Stewart–Kirchoff law of radiation and absorption is not applicable to them, while so far as known it is applicable to the former which also are continuous in their action both day and night.

Since convection necessarily is absent above the upper inversion and since the thermal conductivity of gases is very small, therefore anything beyond this plane is in the position, nearly, so far as earth radiation is concerned, of a body receiving radiation from a flat black surface of infinite extent; because the water vapor below is black to long waves, the only kind given off by objects at the prevailing low temperatures.

Consider first the condition of an object placed between two such surfaces parallel to each other and close together in comparison to their linear dimensions. Let their temperature be T_2 absolute; then whatever the object placed between them its temperature will become T_2 also, because it is practically surrounded by walls at this constant temperature.

Now let a slab of this substance, say one centimeter square, δt thick, be placed parallel to the large planes and let H_2 be the number of heat units of wave-length λ_e they supply to it per second, and let A_2 be the number of units of this energy it absorbs per second. Then if E_2 is the number of units of energy of the same wave-length it radiates per second, as a result of its hotness only, the following equation is given by the Stewart-Kirchoff law.

$$\left(\frac{\frac{E_2}{A_2}}{H_2}\right)_{\lambda_e,\,T_2} = (R_2)_{\lambda_e,\,T_2}$$

The number of heat units a black body radiates per second within the given range of wave-length—under the given conditions the total radiation—when at temperature T_2.

But the state is a steady one, and, therefore, $E_2 = A_2$, and $R_2 = H_2$. Now let one of the parallel surfaces be removed and the other retained at its old temperature T_2. The heated body, small slab, will come to

a new state of equilibrium at a temperature T_1, and give the relations

$$\left(\frac{\frac{E_1}{A_1}}{H_1}\right)_{\lambda_v, T_1} = (R_1)_{\lambda_v, T_1}, \; E_1 = A_1 \text{ and } R_1 = H_1.$$

Since H_2 is the radiation per second incident on the heated body from the two planes jointly, while H_1 is the corresponding amount from but one of them at the same temperature, then evidently

$$\frac{H_2}{H_1} = \frac{R_2}{R_1} = \frac{2}{1}.$$

But from the Stefan-Boltzmann law we know that

$$\frac{R_2}{R_1} = \frac{T^4_2}{T^4_1} = \frac{2}{1}; \text{ and}$$

$$\text{hence } \frac{T_2}{T_1} = \frac{119}{100}, \text{ approximately.}$$

The second condition above described, that is, the single radiating black surface heating an object in its neighborhood, is analogous to the effective radiating surface of the earth at temperature T_2 and the dry diathermanous atmosphere above the surface of the upper inversion at temperature T_1.

Since the absorption of the dry atmosphere is minute the value of T_1 if determined by earth radiations alone, would be nearly constant—tho of slowly decreasing value—with increase of elevation. A knowledge of these two temperatures should, therefore, show to what extent the temperature of the upper air is determined by that of the effective radiation surface. And both are known; the latter calculated by Abbot and Fowle[21] from the results of many observations made chiefly by them at the Astrophysical Observatory of the Smithsonian Institution, and the former directly obtained with sounding balloons. The temperature of the upper inversion varies thru a considerable range, but averages something like —55° C. Therefore, assuming this to be due entirely to earth relations, we get

$$\frac{T_2}{218} = \frac{119}{100}, \text{ or } T_2 = 259^\circ \text{ C., approximately.}$$

But this is about the temperature[21] required by the solar constant for the effective radiating layer, that is, a layer of dense water vapor—the equivalent nearly at this temperature of a black surface—that radiates the given amount of energy; and, therefore, it seems that in the main the temperature of the upper air is due to radiation from the

[21] Annals of the Astrophysical Observatory of the Smithsonian Institution. v. 2, p. 174.

moisture of the lower levels and that the dry air is extremely diathermanous.

The effective temperature, or temperature of the effective layer, is found in middle latitudes about 3 kilometers above the surface of the earth in the winter and 5 in the summer, or say 4 kilometers for the year.

Consider now the effect of the solar radiation on the outer atmosphere. The oxygen of this region absorbs the ultraviolet and a little of the red, and besides slight heating produces, it is believed, electrical and chemical effects. That is, it is thought that the air is ionized and that both ozone[22] and nitrogen pentoxide,[23] probably, are produced. The blue of the sky would then be due in part, as many have suggested, to this ozone. Each of these compounds, but especially ozone,[24] has absorption bands scattered thru a wide range of the spectrum from well within the ultraviolet to 12 μ or farther in the infrared. It has a strong band at and below 0.3 μ that may account in part for the sharp limitation near this wave-length of the observed solar spectrum. It has another well-defined band at 0.6 μ, which possibly adds something to the great depression found in the solar intensity curve at this place. There are several other bands, but in the infrared, one of which 8.5 μ to 10.5 μ is very strong, and of course would absorb earth radiations.

Spectroscopically then, assuming the existence of ozone in the high atmosphere, for which there is much evidence, the known part of the earth's atmosphere is divisible into three regions—the black body, the diathermanous, and the selectively absorptive. The first is the water vapor region, which totally, or nearly so, absorbs long wave radiations. The second is the dry air just above this region; and the third is the high atmosphere, presumably rich in ozone, in which absorption is marked, but selective. There is reason to believe, however, that the outer atmosphere shades away in density with elevation and changes in composition until at a height of 100 kilometers or less it is again diathermanous with nothing but a little hydrogen and possibly some helium left.

Since both ozone and water vapor transmit solar radiation fairly well, most of it reaches the lower levels and the earth, where it is absorbed and there reemitted as long waves for which water vapor is

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[22] Lyman, Astro. Jr. v. 27, p. 87, 1908. Henriet et Bonyssy, C. R., May 11, 1908, p. 977.

[23] Warburg und Leithäuser, Annalen der Physik. v. 23, p. 209, 1907.

[24] Ladenburg und Lehmann, Ann. d. Phys. v. 21, p. 305, 1906.

nearly opaque. *In this way the lower atmosphere becomes heated and rises, in which act it cools by expansion and by radiation until it reaches a minimum temperature determined mainly by the sum total of the energy emitted from lower levels.* Above this place the temperature slowly rises, presumably because of the absorption as explained, due to oxygen and to ozone.

The lower levels of the upper atmosphere should be comparatively free from ozone, partly because it is less rapidly produced at these levels and partly because it slowly reverts into ordinary oxygen. Besides, a small amount of water vapor must diffuse across the inversion plane, since it extends in appreciable quantities to this level, as we know by the cirrus clouds; and it is probable that this water vapor, as it comes in contact with the ozone of the inversion region, converts it by way of hydrogen peroxide into ordinary oxygen. These two processes, the spontaneous and the chemical reduction of ozone to oxygen, would keep this place constantly diathermanous. Presumably too above the limits of the water vapor, where the oxygen absorption of the ultraviolet is greatest, the largest amounts of ozone are found. If so, then this region will absorb a larger amount of solar energy as well as more of the earth's radiation than will the diathermanous layer below, and thus be kept constantly warmer. Besides this, difference in temperature may be somewhat accentuated, or at least maintained, at night by the rapid radiation thru the outer atmosphere of the upper levels of the water vapor, causing it to cool more rapidly than the air above it, in a manner analogous to the radiation phenomena involved in the formation of anchor ice, and of morning inversions at the surface of the earth.

CAUSE OF ABRUPT CHANGE OF TEMPERATURE GRADIENT.

The sharp definition of the place of inversion probably is due to the existence at that level of a more or less well-formed cloud veil, which becomes to that extent the locus of insolation. If so, then a sky with extensive cirrus clouds should give immediately above the inversion—presumably the upper surface of a cirrus—a rapid increase of temperature with elevation, while a serene sky should furnish a curve of gradual transition from the one gradient to the other. Both these conditions and results are shown by the curves, which are in harmony with other flights under similar circumstances. No. 2 shows the effect of cirrus clouds, and No. 6 the gradient when the sky is perfectly clear. In the one the change is gradual; in the other it is abrupt and large.

CAUSE OF SEASONAL DIFFERENCE IN HEIGHT OF INVERSION.

During the summer the moisture content of the air, because of increased temperatures, is greater than it is in winter, and extends to greater elevations, and therefore the effective radiating surface is correspondingly elevated. This combined with the difference in the gradients for the two seasons—less in summer than in winter—puts the inversion level at its greatest elevation during the warmer weather.

CAUSE OF SEASONAL DIFFERENCE IN TEMPERATURE AT INVERSION SURFACE.

The lower atmosphere and the surface of the earth receive more solar energy during the summer than in the winter, and consequently must radiate more at this season. Therefore, if the inversion temperature is determined mainly, or even largely, by earth radiation, it should be greatest in summer and least in winter; and this is supported by the published observations from Trappes, from Uccle, and from Strassburg, and presumably therefore is generally true.

CAUSE OF LATITUDE EFFECT ON HEIGHT OF INVERSION.

Change in latitude at any given season is analogous, meteorologically, to change of season at any given latitude, and might be expected to lead, as it does, to a corresponding change in the height of the inversion; and presumably, too, to a like change in its temperature.

CAUSE OF RELATION BETWEEN BAROMETRIC PRESSURE AND HEIGHT OF INVERSION.

Normally the region of high barometer is one of clear weather, while a low barometer is accompanied by precipitation which correspondingly heats the upper air and decreases its temperature gradient. As a result of this heating the place of inversion is shifted to one of lower level and higher temperature, as well illustrated by curve No. 4

CONCLUSIONS.

1. Considered from the standpoint of temperature gradients, the explored portion of the atmosphere is divisible into three parts. I. The region of terrestrial disturbance, extending from the ground to an elevation of about 3,000 meters above its surface. II. The region of uniform changes, from the top of I to roughly 10,000 meters above sea. III. The region of permanent inversion, or all that explored portion, at least, that lies above the plane of the upper inversion.

2. Spectroscopically the known atmosphere is divisible into three parts. (*a*) The black body portion, coincident with the region of and

due to the relatively dense water vapor. (*b*) The diathermanous, or the dry air next above the water vapor. (*c*) The selectively absorptive, or the air of the isothermal layer, presumably rich in ozone.

3. The isothermal layer is due mainly to earth radiations. The lower heated air rises and cools by expansion until it reaches a minimum temperature fixt by the radiation from below at that time and place.

4. The differences in the temperature gradients of the region of uniform changes, the differences in the heights of the plane of inversion, and in the temperatures at which inversion takes place, as determined by season, by latitude, and by storm conditions, are all accounted for by the corresponding differences in the moisture content and in the radiation of the atmosphere.

5. The temperature and the height of the upper inversion are given by the equations

$$T_1 = 0.84\,T_2, \text{ and}$$

$$h_1 = h_0 + \int_{T_0}^{T_1} \frac{dh}{dT}$$

in which

h_0 = any initial height. It may be the surface of the earth.

h_1 = the height of the inversion surface.

$\frac{dh}{dT}$ = the reciprocal of the temperature gradient where the temperature is T.

T_0 = the absolute temperature at the elevation h_0.

T_1 = the absolute temperature at the level of inversion, h_1.

T_2 = the absolute temperature of the effective radiating surface, or of a dense layer of water vapor radiating the given amount of energy.

SUGGESTIONS.

Much needs yet to be done in observing temperature gradients during special types of weather, particularly in the centers and about the borders of cyclones. It would also be well to take the height of the high cirrus at the time each ascension is made.

Many laboratory investigations are also desirable in connection with the absorption and radiation of the several gases and vapors of the atmosphere, singly and variously combined, at different pressures and different temperatures. The investigations indicated would necessarily be long, and some of them most difficult, but only in so far as they

and kindred ones are completed, can meteorological problems of the nature of those discust in this paper be fully solved.

NOTE.

The substance of this paper was read July 1, 1908, before the Physics Section of the American Association for the Advancement of Science,[35] and again on August 27, 1908, before the Astronomical and Astrophysical Society of America.

[35] Science, August 21, 1908, p. 256.

AURORAL DISPLAYS AND MAGNETIC DISTURBANCES AT MOUNT WEATHER DURING SEPTEMBER, 1908.

By W. R. Gregg.

Several displays of the aurora, remarkable for their brilliancy and wide extent, occurred during the month of September, 1908. They were accompanied by large magnetic disturbances, which have been studied in connection with notes on changes in the form and appearance of the auroras, as observed at Mount Weather, Va., and elsewhere.[1]

September 4–5.—A fairly large magnetic disturbance occurred between 12:45 p. m. of the 4th and 11 p. m. of the 5th; it was most violent from 6 p. m. to midnight of the 4th, during which interval the range in the declination was 37.4′, in the horizontal force 186γ (1γ= 0.00001 C. G. S. unit), and in the vertical force 182γ. No aurora was seen at Mount Weather on this evening, but a very bright one, with rapidly flashing streamers of rose pink color was observed by Mr. C. S. Wood at the Thousand Islands, N. Y., between 9 p. m. and midnight.

September 11–12.—On the 11th a very brilliant aurora was observed at Mount Weather between 7:10 and 8:30 p. m. It first appeared as a long, slightly curved arch of whitish color, about 2° in breadth, its central point being about 18° above the horizon and 5° west of true north, or practically in the magnetic meridian. At 7:40 p. m. it broke up rapidly into streamers, which gradually increased in extent until at 7:50 p. m. they reached from the horizon to the zenith. The streamers did not flash, altho they changed rather rapidly; they were brilliantly colored, a large portion having a bright rose tint, while others showed a greenish yellow. The former appeared almost entirely to the west of the magnetic meridian during the earlier part of the display, but later they covered all sections. At 7:55 p. m. there was seen a rather inferior draped aurora, but this lasted only a short time. As the moon rose shortly after 8 p. m. further observation at this place was impossible.

In the northern portions of the United States, however, it seems to have been brighter, newspaper and other reports indicating that it was clearly seen until 11:30 p. m. At Cleveland, Ohio, it was carefully

[1] The time used in this article is that of the seventy-fifth meridian, which is five hours slower than Greenwich mean and 11.6 minutes faster than mean local time.

observed by Father Odenbach of St. Ignatius College; he states that it covered the sky from the northern horizon to a point 10° south of the zenith. Curtain effects were observed about 30° above the northern horizon, and the color and other characteristics were similar to those seen at Mount Weather.

The magnetic storm which accompanied this display was the largest which has occurred since October 30–31, 1903, and in some respects it seems to have eclipsed even that. It began very suddenly at 4:47 p. m., when the declination swung rapidly to the east, and the horizontal and vertical forces both increased in value. The record of the declination is complete and shows that the farthest point to the west was reached at 8:16 p. m. The greatest easterly declination occurred at 8:43 p. m., the total range being 1° 27.8′ within twenty-seven minutes of time. It is of interest to note that the range experienced at Kew Observatory, England, was 1° 27′ and that the time of beginning of the storm at that observatory was 9:47 p. m., Greenwich mean time, or exactly the same moment of time as that indicated at Mount Weather.[1] After 8:43 p. m. the declination continued to fluctuate rapidly until 4 a. m. of the 12th, a very pronounced feature being the peaks or turning points which occurred at 8:16 and 10:46 p. m. of the 11th and 12:18 and 1:53 a. m. of the 12th.

The horizontal force underwent frequent changes, the spot of light passing across the sheet so rapidly that in many places it is impossible to follow it. At about 12:30 a. m. of the 12th, the force became so low that the spot of light left the paper entirely for several hours. However, from the record obtained with a Wild magnetograph it has been possible to compute the range which occurred. This instrument records changes in the north-south component of the force. The maximum value occurred at 5:16 p. m. of the 11th, and the minimum at 12:24 a. m. of the 12th. The range indicated is 219.8 millimeters which, multiplied by the scale value of the instrument, or 2.74γ, gives as the absolute range in the north-south component, 602γ. Inasmuch as the declination at this place is small, the range in the total horizontal force would be only slightly greater than that in the north-south component, or about 605γ.

A nearly complete record of changes in the vertical force was obtained with the Wild magnetograph. The spot of light left the sheet at 7:25 p. m. of the 11th, but returned shortly, and the force diminished to such an extent that the magnet was upset at 8:14 p. m., or practically the time at which the declination reached its farthest

[1] Nature, September 24, 1908, p. 508.

point to the west. At 9:26 p. m. the force had increased sufficiently to pull the magnet up into position, and it continued to record as before, having suffered no change in scale or base line value. It is impossible to give the total range in the vertical force, but that of which there is a record is 179.6 millimeters, or 645 γ. The nearest approach to this within recent years occurred from February 8 to 10, 1907, when the range was about 575 γ.

September 29–30.—The aurora of the 29th, altho not as bright as that of the 11th, was observed to better advantage and in greater detail, owing to the absence of moonlight. It first appeared at 7:15 p. m. as a low-lying arch, about 2° in breadth and 8° above the horizon at its central point. At 7:25 p. m. streamers of a reddish hue shot up toward the zenith, but lasted only a short time. There was little change from this time until 9 p. m., after which streamers were continually forming and dying out. They were especially active and brilliant at 9, 9:12, 9:18, 9:35, and 10:15 p. m. The streamers were always white like the arch, except at 7:25 and 9:35 p. m., when they were of a reddish hue. After 10:30 p. m. the aurora became less active and by 11 p. m. had entirely disappeared. The center of the arch, which at first was about 8° above the horizon, gradually rose to about 12° by 9:30 p. m.; it was very steady in appearance, except when the streamers formed, and even then, as a rule, it could be plainly seen.

On the evening of September 30 at 7:37 p. m. there was another display of the aurora, lasting, however, but a short time. It consisted of a portion of an arch in the west; had it been complete, its center would have been about 20° above the horizon. Its appearance changed rapidly, but there were no streamers; at 8:10 p. m. it disappeared and was not seen again.

Clippings from different newspapers and a note in Nature, October 8, 1908, indicate that the aurora was very generally seen thruout Europe and North America, not only on the 29th and 30th, but also on the 28th. In Alaska it was reported as the finest display in several years; its color in that territory varied from faint green to rich purple.

A very large magnetic disturbance began at 8:31 p. m. of the 28th and continued until 4 a. m., October 1. The declination magnet oscillated considerably until 11:16 p. m. of the 28th, when it went quickly to the eastward, reaching the farthest point at 11:50 p. m. It then swung gradually to the westward until 1:24 a. m. of the 29th, the range during this interval being 37.6′. The horizontal force diminished greatly, the trace with the aid of a reserve mirror giving a range

from 8:32 p. m. of the 28th to 12:32 a. m. of the 29th of 288 millimeters, or 490 γ. Owing to the severity of the storm, the vertical force magnet was upset at 12:25 a. m. of the 29th. The range up to this time was 76 millimeters, or 297 γ. The magnet was rebalanced during the forenoon of the 29th, and the greatest range recorded before it was again upset was 407 γ.

After 2 a. m. of the 29th the elements were comparatively quiet until 8:35 a. m.; at this time the declination moved to the west, the horizontal force decreased and the vertical force increased. Upon comparing the traces with the observed times of flashes in the aurora the following points of interest were found. Some of the largest fluctuations took place before twilight, indicating that the conditions which gave rise to the aurora existed for a considerable time before it was possible to see it. At 7:15 p. m., when the aurora was first seen, the declination was slightly to the west of its normal value, and the forces were about normal. At 7:25 p. m., when were observed the first streamers, the declination shifted rapidly to the eastward, the horizontal force decreased and the vertical force increased. The declination soon returned, but both forces continued to change until 8:45 p. m., when they began to return slowly. None of the elements seems to have been affected appreciably by the streamers which were observed at 9 p. m., and which extended only a short distance upward from the arch. At 9:12 p. m., however, when more brilliant streamers were seen, all elements shifted rapidly, the declination going to the east, the horizontal force increasing and the vertical force decreasing. At 9:37 p. m., when the streamers were of a brilliant reddish hue, the declination stood at its farthest point east during the storm. It immediately returned to the west, continuing in this direction until 9:54 p. m.; the range during this interval, 17 minutes, was 57.3′. The horizontal force underwent a change of 170 γ in value, which is rather small, considering the large range in the declination. The vertical force magnet was upset, so no record of its range is available. From this time until 11 p. m. the aurora rapidly changed in appearance, and the fluctuations of the magnets were correspondingly rapid. The declination was farther east than normal after the disappearance of the aurora, but gradually returned to the west, reaching the farthest point at 5:57 a. m. of the 30th, the range for the entire storm being 59.1′.

Thruout the 30th there was considerable disturbance which was not greater during the auroral display in the evening than either before or after, seeming to indicate that the aurora was merely the visible appearance of a condition which had prevailed for some time. After

4 a. m., October 1, the elements assumed their normal value, which is noteworthy, inasmuch as the horizontal force is usually deprest for some time subsequent to a storm.

There were several very large sun-spots during the month, especially at the times of auroral display. On the 11th two of the largest which have been seen in several months were near the sun's western limb. There were also two smaller spots near the eastern limb, and one near the meridian. On the 28th and 29th three small spots were seen near the meridian, and one of moderate size near the eastern limb; the latter on the 30th was attended by two smaller spots which had not been visible before.

Meteorological conditions were not unusual, except that very dense haze prevailed on the 11th, 29th, and 30th, a notable feature being that the lower layers of the atmosphere were very clear, whereas, at a moderate elevation, heavy layers of haze existed. The evenings were in general quite clear, but in the daytime, in addition to the dense haze, there were numerous cirrus and cirro-cumulus clouds.

It will be remembered that auroral displays, accompanied by large magnetic disturbances, occurred also on March 26 and 27 and May 25 of this year.[3] It is unusual for so many to occur within a short period and it is of interest to note in this connection that, judging from the records of the past, a period of maximum abundance of auroras is now due. The culminating points already established are 1728, 1787, and 1847,[4] giving a period of about sixty years, which agrees closely with that from 1847 to 1908, or sixty-one years. The auroras of this year seem therefore to give added proof of the existence of a secular periodicity in the occurrence of the aurora, and also of the simultaneity of auroral and sun-spot frequencies.

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[3] Mount Weather Bulletin, Vol. I, part 4., pp. 232–236.

[4] E. Loomis, Treatise on Meteorology, p. 169. E. Walker, Terrestrial and Cosmical Magnetism, p. 125.

UPPER AIR TEMPERATURES FOR JULY, AUGUST, AND SEPTEMBER.

By the Aerial Section—W. R. BLAIR in charge.

During the ninety-two days of this period it was necessary to use balloons thirty times because of low winds, while during the same period last year balloons were used but three times. The mean surface wind velocity for the three months was 4.3 meters per second. The prevailing wind direction was southeast. The mean of the highest altitudes reached by means of the balloons is 2,068 meters; by means of the kites, 2,926 meters. The highest balloon ascension, 2,988 meters, was made on July 27; the highest kite flight during the period, 6,749 meters, was made September 30. This flight is 295 meters lower than that of October 3, 1907, and is the third highest so far obtained by means of kites. A temperature of −24.6 C. was recorded at the highest point of this flight. This is the lowest temperature reached during the three months, and is only 3.3° C. above that found on January 2, 1908, at a level only 1,500 meters lower.

A comparison of the isothermal charts for these three months with those of January, February, and March will show the isotherms nearer together in the summer months, especially at the lower levels, i. e., in general, a greater decrease in temperature with altitude in the summer than in the winter.

The temperatures observed at Trapp have been put on these charts and the isotherms are put in with dot and dash lines. Among other things it will be noted that the general tendency of these lines is to slope positively in the forenoon, this slope diminishing until in the evening the isotherms are about perpendicular. The largest temperature difference between the two stations occurs in the forenoon, Trapp having the higher temperature, and the smallest in the evening. The minima and maxima occur somewhat later on the mountain top than in the valley. The following group of curves, figs. 1, 2, and 3, in which the mean hourly temperatures for each month are plotted with the time is a still more graphic representation of the above fact and takes the place of the table of means published in Part I, No. IV for Trapp and Mount Weather. The Audley temperatures are also charted.

During the last week in July there was an area of low pressure moving up the South Atlantic coast. The maximum intensity was reached

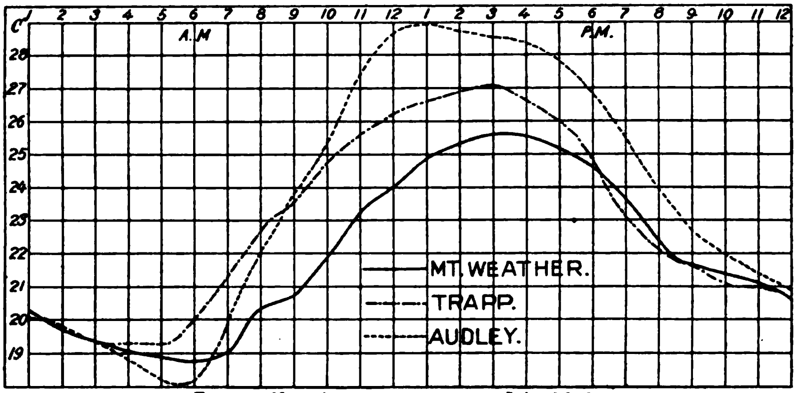


Fig. 1.—Mean hourly temperatures, July, 1908.

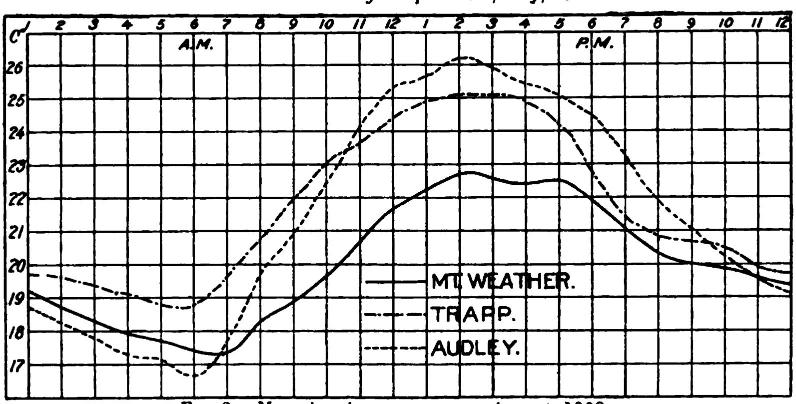


Fig. 2.—Mean hourly temperatures, August, 1908.

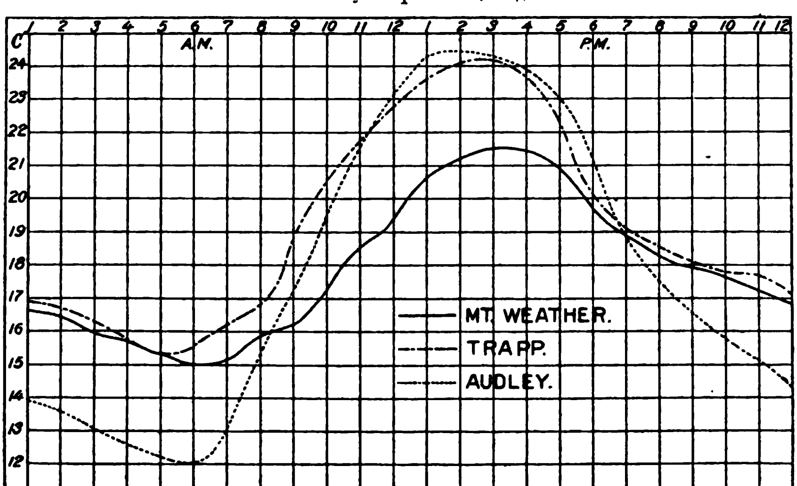


Fig. 3.—Mean hourly temperatures, September, 1908.

on the 30th and 31st, on which days the east to northeast winds were the deepest so far sounded at this observatory, 5,299 meters.

A well-marked and characteristic inversion appears on September 15 to 19, inclusive, on the first day, about 2,500 meters above sea-level, on the last, near the surface of the mountain. It happens that the flights on these days were sufficiently high to afford complete data and it is thought that a description of this typical case may be of interest, especially so in the interpretation of other inversions of this type upon which the data available is less complete. The advent of this inversion is preceded by a small temperature change with altitude at 2,900 meters on September 14. During these five days, an area of high pressure which was central over Vermont on September 15 moved southwestward over the observatory. The highest pressure in this area was 775.2 millimeters on the morning of the 15th and decreased to 765.0 millimeters on the morning of the 19th. Under the influence of this area of high pressure, the surface wind was northeast on the 14th, southeast on the 15th, and northwest during the remainder of the period. On the 14th and 15th the change in wind direction with altitude was counter-clockwise, while during the remainder of the period it was clockwise. The upper current in which the inversion occurred varied from north-northeast on the 15th to north-northwest on the 19th. These warmer northerly winds aloft are apparently due to an area of low pressure which was central about 300 kilometers east of the southern extremity of Florida at 8 a. m. on the 14th and moved north-northeast along the coast, reaching the Gulf of St. Lawrence at 8 a. m. on the 19th. This area of low pressure seems to have overhung the weak area of high pressure. The deep northeast winds occurring July 30 to August 1, inclusive, are due to the somewhat similar conditions which prevailed on these days, and a similar tho less-marked inversion was observed. Most other inversions shown on the charts, especially those which continue thru two or three days, are accompanied by a type of pressure distribution similar to the above, i. e., an advancing area of high pressure overhung by a passing or retreating area of low pressure.

The isothermal charts for July, August, and September have been drawn to the same vertical scale as those in volume 1, but the horizontal scale has been doubled.

RESULTS OF CAPTIVE BALLOON ASCENSION.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
July 1, 1908:	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
10:15 a. m.	23.8	71	sw.	1.3	526	23.8	71	sw.	1.3
10:30 a. m.	24.8	67	sw.	1.3	1,218	23.4	......	o	....
10:46 a. m.	24.0	74	se.	1.3	2,150	18.5	......	sw.	....
11:00 a. m.	24.0	78	se.	2.2	2,061	12.8	......	ssw.	....
11:15 a. m.	23.9	74	sw.	2.7	1,982	18.6	......	ssw.	....
11:30 a. m.	24.3	71	se.	2.7	1,738	15.6	......	o	....
11:40 a. m.	23.9	74	s.	2.7	1,417	17.6	......	o	....
11:53 a. m.	24.4	72	se.	3.1	1,107	18.8	......	sse.	....
12:00 m.	25.0	73	s.	2.7	526	25.0	73	s.	2.7

RESULTS OF KITE FLIGHTS.

Date and hour.	Air temperature.	Rel. hum.	Dir.	Velocity.	Height.	Air temperature.	Rel. hum.	Dir.	Velocity.
July 2, 1908:									
10:33 a. m.	25.0	71	se.	4.0	524	25.0	71	se.	4.0
10:42 a. m.	25.7	78	se.	3.6	886	22.5	......	sse.	....
10:53 a. m.	25.2	78	se.	4.0	1,225	21.3	......	s.	....
12:19 p. m.	26.6	65	s.	4.5	1,573	17.4	......	s.	....
12:45 p. m.	26.4	64	se.	5.4	2,026	14.6	......	s.	....
1:37 p. m.	26.1	66	se.	4.5	2,266	12.0	......	wsw.	....
1:58 p. m.	26.4	64	sw.	6.3	1,942	15.4	......	wsw.	....
2:06 p. m.	25.3	69	sw.	4.9	1,713	16.0	......	s.	....
2:22 p. m.	25.0	68	sw.	4.5	1,203	18.2	......	s.	....
2:37 p. m.	25.2	70	se.	4.0	914	22.3	......	s.	....
2:43 p. m.	25.7	70	se.	3.6	526	25.7	70	se.	3.6

RESULTS OF CAPTIVE BALLOON ASCENSION.

Date and hour.	Air temperature.	Rel. hum.	Dir.	Velocity.	Height.	Air temperature.	Rel. hum.	Dir.	Velocity.
July 3, 1900:									
1:46 p. m.	24.4	74	s.	2.7	526	24.4	74	s.	2.7
1:55 p. m.	24.4	74	s.	2.7	1,948	14.5	......	sw.	....
2:12 p. m.	24.6	74	se.	3.1	1,865	15.0	......	sw.	....
2:28 p. m.	24.4	74	se.	3.1	1,459	16.8	......	sw.	....
2:31 p. m.	24.3	74	se.	3.6	1,301	17.1	......	ssw.	....
2:49 p. m.	24.4	76	s.	2.7	526	24.4	76	s.	2.7

July 1, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,286 m. About 2/10 Ci.-St. and a few Cu. moving from the west-southwest were visible. Pressure was high over New England and relatively low over Lake Huron.

July 2, 1908.—Five kites were used; lifting surface, 36.4 sq. m. Wire out, 4,572 m.; at maximum altitude, 3,353 m.

At the beginning 6/10 Ci.-St. moving from the west and a few Cu. moving from the south were observed. The higher clouds decreased to 1/10 Ci.-St. and the lower clouds increased to 6/10 Cu. by the end of the flight.

An extensive area of relatively high pressure, with centers over northern Michigan and northeastern Colorado, occupied the region east of the Rocky Mountains. Solar halo from 10:30 a. m. to 11:31 a. m. Cu. past under leading kite at an altitude of 1,524 m.

July 3, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,591 m. About 8/10 Cu. moving from the southwest were visible during the ascension. High pressure prevailed from the Rocky Mountains eastward.

RESULTS OF CAPTIVE BALLOON ASCENSION.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
July 4, 1908:									
10:25 a. m.	24.0	87	sw.	3.6	526	24.0	87	sw.	3.6
10:33 a. m.	25.0	83	s.	3.1	1,840	15.2	......	wsw.	....
10:50 a. m.	24.4	80	sw.	4.0	1,382	18.1	......	wsw.	....
11:09 a. m.	25.6	79	sw.	2.7	1,124	19.4	......	wsw.	....
11:25 a. m.	25.7	78	sw.	3.1	920	20.4	......	wsw.	....
11:45 a. m.	26.0	75	sw.	3.6	526	26.0	75	sw.	3.6

RESULTS OF KITE FLIGHTS.

Date and hour.	Air temperature.	Rel. hum.	Dir.	Velocity.	Height.	Air temperature.	Rel. hum.	Dir.	Velocity.
July 6, 1908:									
5:23 p. m.	23.7	79	w.	5.4	526	23.7	79	w.	5.4
5:33 p. m.	23.9	75	sw.	5.4	794	23.0	......	wsw.	....
5:46 p. m.	23.9	75	sw.	5.4	1,031	20.5	......	sw.	....
6:03 p. m.	24.4	71	sw.	9.4	1,352	18.2	......	sw.	....
6:47 p. m.	23.4	82	w.	5.8	1,806	14.6	......	sw.	....
7:23 p. m.	23.2	80	w.	5.4	2,275	10.6	......	sw.	....
7:45 p. m.	23.4	76	w.	5.8	1,832	13.5	......	sw.	....
7:53 p. m.	23.3	75	sw.	6.7	1,403	16.4	......	sw.	....
8:03 p. m.	23.3	74	sw.	5.8	1,021	20.2	......	sw.	....
8:12 p. m.	23.9	69	sw.	6.7	894	22.9	......	sw.	....
8:17 p. m.	23.9	69	sw.	7.2	526	23.9	69	sw.	7.2
July 7, 1908:									
7:00 a. m.	22.1	80	nw.	6.7	526	22.1	80	nw.	6.7
7:58 a. m.	22.4	80	nw.	4.5	906	22.5	......	wnw.	....
10:14 a. m.	25.1	68	w.	4.5	1,182	20.1	......	wsw.	....
10:17 a. m.	25.3	66	w.	4.0	1,312	18.6	......	wsw.	....
10:23 a. m.	25.6	66	w.	4.0	976	21.5	......	wsw.	....
10:31 a. m.	25.6	66	w.	3.6	526	25.6	66	w.	3.6
2d flight.									
2:43 p. m.	29.4	53	sw.	5.8	526	29.4	53	sw.	5.8
2:58 p. m.	29.0	52	sw.	5.8	846	26.0	......	sw.	....
3:47 p. m.	29.4	53	sw.	6.3	1,139	22.0	......	wsw.	....
4:10 p. m.	29.3	54	sw.	4.5	1,484	19.0	......	wsw.	....
4:20 p. m.	29.3	56	sw.	4.5	526	29.2	56	sw.	4.5

July 4, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,286 m. About 8/10 Ci,-St., Ci.-Cu., A.-Cu., Cu., and St. were visible moving from the west-southwest. The balloon was in clouds from 10:26 to 10:46 a. m., 11:06 to 11:11 a. m., and from 11:23 to 11:25 a. m. A solar halo was seen from about 10:30 to 10:45 a. m.

Pressure was high over the Atlantic coast from South Carolina northward, and was relatively low over the region of the upper Lakes.

July 6, 1908.—Six kites were used; lifting surface, 38.3 sq. m. Wire out, 4,572 m.; at maximum altitude, 3,354 m.

The sky was nearly overcast with Ci.-St. and St.-Cu. moving from the west-southwest.

Pressure was high over North Carolina and Tennessee and low over Lake Michigan.

July 7, 1908.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 2,134 m.; at maximum altitude 1,219 m.

At the beginning of the flight, 6/10 Ci.-Cu. were visible moving from the west. By 2:40 p. m. these had been replaced by 4/10 A.-Cu. from the west-southwest and 1/10 Cu. from the southwest.

Second flight: Four kites were used; lifting surface, 25.7 sq. m. Wire out, 1,524 m.; at maximum altitude the same.

Clouds were visible as follows: 1/10 Cu. moving from the west-southwest and 1/10 Cu. from the southwest.

At 8 a. m. a high was central over the south Atlantic coast and a low over Lake Huron.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Veocity.
July 8, 1908:	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
7:01 a. m	16.6	85	nw.	8.9	526	16.6	85	nw.	8.9
7:15 a. m	16.6	85	nw.	8.5	925	13.1	......	nw.	....
7:25 a. m	16.6	84	nw.	8.0	1,141	10.3	......	nw.	....
7:35 a. m	17.4	79	nw.	8.9	1,488	16.8	......	nw.	....
7:58 a. m	16.7	82	nw.	10.7	1,928	13.1	......	nw.	....
8:32 a. m	17.2	77	nw.	8.9	2,626	8.5	......	nw.	....
11:06 a. m	19.2	57	nw.	10.7	3,265	4.3	......	w.	....
11:40 a. m	19.6	53	nw.	8.9	3,785	2.4	......	w.	....
12:03 p. m	20.6	54	nw.	8.9	3,334	3.3	....	w.	....
12:56 p. m	21.7	47	nw.	7.6	2,767	8.8	......	wnw.	....
1:15 p. m	21.7	42	nw.	8.0	1,938	14.0	......	nw.	....
1:34 p. m	22.6	43	nw.	8.0	1,528	16.1	......	nw.	....
1:41 p. m	22.4	42	nw.	8.0	1,286	14.8	......	nw.	....
1:57 p. m	22.6	41	nw.	7.2	860	19.1	......	nw.	....
2:13 p. m	22.8	40	nw.	6.7	526	22.8	40	nw.	6.7
July 9, 1908:									
6:58 a. m	15.6	68	e.	4.9	526	15.6	68	e.	4.9
7:21 a. m	15.8	68	e.	4.5	825	14.1	......	se.	....
8:03 a. m	16.2	68	se.	4.5	1,169	12.5	......	se.	....
9:32 a. m	18.3	62	se.	4.5	768	15.2	......	se.	....
9:36 a. m	18.1	62	se.	5.4	526	18.1	62	se.	5.4

RESULTS OF CAPTIVE BALLOON ASCENSION.

July 9, 1908:									
1:55 p. m	20.9	52	se.	2.7	526	20.9	52	se.	2.7
2:05 p. m	21.4	53	se.	2.2	1,082	16.0	......	sse.	....
2:31 p. m	21.1	56	se.	2.2	2,114	11.4	......	ese.	....
2:55 p. m	21.5	54	se.	1.8	1,538	11.3	......	ene.	....
3:08 p. m	21.9	60	s.	2.2	1,255	13.6	......	se.	....
3:21 p. m	21.5	53	se.	1.8	1,024	15.7	......	se.	....
3:35 p. m	21.9	54	s.	1.8	727	19.2	......	sse.	....
3:38 p. m	22.1	55	s.	1.8	526	22.1	55	s.	1.8

July 8, 1908.—Seven kites were used; lifting surface, 44,6 sq. m. Wire out, 8,016 m.; at maximum altitude, 7,925 m.

At the beginning 1/10 Ci.-Cu. from the west-southwest and 4/10 St.-Cu. from the northwest were observed. The higher clouds increased gradually to 4/10 Ci.-Cu. by 9:06 a. m. and from 2/10 to 4/10 Ci.-Cu. were present during the remainder of the flight. The lower clouds had disappeared at 12:11 p. m.

Pressure was high over Illinois and low over the lower St. Lawrence.

July 9, 1908.—For the kite flights five kites were used; lifting surface, 38,3 sq. m. Wire out, 3,200 m.; at maximum altitude, 2,134 m. For the balloon ascension one balloon was used; capacity, 25.6 cu. m. Wire out, 2,225 m.

The sky was nearly overcast thruout the day with Ci.-St. moving from the west and west-southwest, accompanied from 8 to 10 a. m. by A.-St. moving from the southwest. A solar halo was observed at 8 a. m., and continued to 4 p. m.

Pressure was high over Pennsylvania and low off the South Carolina coast.

RESULTS OF CAPTIVE BALLOON ASCENSION.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
July 10, 1908:	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
4:54 p. m.	23.3	54	e.	8.6	526	23.8	54	e.	8.6
4:59 p. m.	23.1	52	e.	3.1	1,302	16.5	......	e.	....
5:13 p. m.	23.9	51	se.	8.1	2,476	18.5	......	o	....
5:31 p. m.	22.8	52	e.	4.0	2,158	16.5	......	o	....
5:47 p. m.	21.9	53	se.	2.7	1,089	13.5	......	e.	....
6:10 p. m.	21.7	58	se.	3.6	526	21.7	58	se.	3.6
Second ascension:									
7:35 p. m.	19.7	59	se.	2.2	526	19.7	59	se.	2.2
7:40 p. m.	19.7	65	se.	8.1	942	16.3	......	se.	....
8:05 p. m.	18.5	70	se.	3.6	2,375	8.3	......	nw.	....
8:16 p. m.	18.9	71	se.	4.5	1,902	10.4	.....	sw.	....
8:30 p. m.	18.6	72	se.	4.0	1,715	12.0	......	se.	....
8:45 p. m.	18.3	76	se.	4.0	1,068	14.0	......	e.	....
8:59 p. m.	18.1	77	se.	4.0	526	18.1	77	se.	4.0
July 11, 1908:									
10:28 a. m.	22.2	69	nw.	1.3	526	22.2	69	nw.	1.3
10:31 a. m.	21.8	74	nw.	1.3	1,061	21.8	......	nnw.	....
10:47 a. m.	24.0	66	e.	1.8	1,829	15.6	......	nnw.	....
11:06 a. m.	24.4	63	nw.	1.3	1,166	21.4	......	nnw.	....
11:55 a. m.	24.2	61	sw.	1.8	781	22.9	......	o	....
11:58 a. m.	24.7	60	se.	1.8	526	24.7	60	se.	1.8

RESULTS OF KITE FLIGHTS.

July 13, 1908:									
7:45 a. m.	21.9	70	nw.	6.7	526	21.9	70	nw.	6.7
7:58 a. m.	22.1	69	nw.	6.7	825	21.7	......	nnw.	....
8:03 a. m.	22.1	69	nw.	5.8	998	24.2	......	n.	....
8:40 a. m.	23.1	69	nw.	4.0	1,285	21.5	......	n.	....
9:03 a. m.	23.9	68	nw.	3.6	1,549	18.7	......	n.	....
9:13 a. m.	23.6	66	nw.	4.0	1,129	21.2	......	ne.	....
9:22 a. m.	23.9	66	nw.	8.6	743	22.7	......	ne.	....
9:28 a. m.	24.1	67	nw.	3.1	526	24.1	67	nw.	3.1

July 10, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out in first ascension, 2,225 m; in second ascension, 2,195 m.

During the first ascension a few Cu. were visible near the horizon. During the second ascension the sky was cloudless.

At 8 a. m. a low was central over Lake Superior. High pressure prevailed along the Atlantic coast.

July 11, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,134 m. The sky was cloudless.

Pressure was high over central Virginia and relatively low off Cape Hatteras. Somewhat lower pressure was central over Lake Huron.

July 13, 1908.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 2,438 m.; at maximum altitude, 1,820 m.

From 1/10 to 2/10 Ci. were present during the flight.

Pressure was high over North Dakota and Alabama and low over the Gulf of St. Lawrence.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
July 14, 1908:	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
7:11 a. m.	23.3	58	w.	4.9	526	23.3	58	w.	4.9
7:20 a. m.	23.3	58	w.	8.0	864	23.3	......	w.	....
7:27 a. m.	23.0	60	w.	5.8	879	24.1	......	wnw.	....
7:58 a. m.	23.1	61	w.	7.2	1,424	19.5	......	wnw.	....
8:20 a. m.	23.2	61	w.	7.6	1,882	15.0	......	wnw.	....
9:32 a. m.	24.0	61	w.	5.4	2,026	15.0	......	wnw.	....
9:55 a. m.	25.0	63	w.	5.8	2,651	7.2	......	w.	....
10:51 a. m.	27.0	61	w.	4.9	3,051	3.5	......	w.	....
11:17 a. m.	27.4	60	w.	4.9	2,336	9.6	......	wnw.	....
11:33 a. m.	27.4	58	w.	4.5	1,082	20.5	......	wnw.	....
11:51 a. m.	28.3	57	sw.	4.0	526	28.3	57	sw.	4.0
July 15, 1908:									
6:59 a. m.	18.3	82	nw.	3.1	526	18.3	82	nw.	3.1
7:10 a. m.	18.4	80	nw.	3.1	886	18.2	......	nnw.	....
7:21 a. m.	18.9	76	nw.	3.1	1,224	15.5	......	nw.	....
7:40 a. m.	19.3	74	nw.	3.1	1,808	10.6	......	nw.	....
8:02 a. m.	19.4	74	nw.	2.7	2,273	7.8	......	wnw.	....
8:24 a. m.	19.9	73	nw.	2.7	2,576	9.0	......	wnw.	....
8:36 a. m.	20.3	72	nw.	2.7	526	20.3	72	nw.	2.7
July 16, 1908:									
7:18 a. m.	13.6	78	nw.	4.9	526	13.6	78	nw.	4.9
7:21 a. m.	14.0	77	nw.	5.4	865	12.7	......	nnw.	....
7:32 a. m.	14.2	76	nw.	5.8	1,220	10.1	......	nnw.	....
7:46 a. m.	14.9	78	nw.	5.8	1,587	12.3	......	nnw.	....
7:57 a. m.	15.4	68	nw.	6.7	1,938	11.6	......	nnw.	....
8:33 a. m.	16.5	60	nw.	6.8	2,818	7.5	......	nnw.	....
9:17 a. m.	17.2	50	nw.	4.9	3,526	0.7	......	nw.	....
10:04 a. m.	18.3	48	n.	5.4	4,348	− 2.2	......	nw.	....
10:46 a. m.	18.8	44	nw.	5.4	5,287	− 9.8	......	nw.	....
11:34 a. m.	19.2	45	nw.	4.0	4,661	− 4.4	......	nw.	....
12:04 p. m.	20.0	43	nw.	3.1	3,671	0.5	......	nw.	....
12:38 p. m.	20.6	37	nw.	3.6	2,949	4.4	......	nnw.	....
12:55 p. m.	21.0	38	nw.	4.9	2,420	7.2	......	nnw.	....
1:02 p. m.	20.9	39	n.	4.9	2,114	10.6	......	nnw.	....
1:06 p. m.	20.9	39	nw.	4.9	1,564	9.6	......	nnw.	....
1:15 p. m.	21.1	39	nw.	3.6	956	16.2	......	nnw.	....
1:20 p. m.	21.7	41	nw.	3.6	526	21.7	41	nw.	3.6

July 14, 1908.—Six kites were used; lifting surface, 38.8 sq. m. Wire out, 5,486 m.; at maximum altitude, 4,420 m.

About 7/10 A.-Cu., moving from the west, were visible until 10 a. m. During the remainder of the flight from 3/10 to 1/10 Ci.-Cu. were visible, moving from the west.

A low was central over the lower St. Lawrence Valley. A ridge of high pressure extended from the Dakotas to the Gulf of Mexico.

July 15, 1908.—Three kites were used; lifting surface, 24.3 sq. m. Wire out, 3,353 m., at maximum altitude.

About 1/10 Ci.-St., moving from the northwest, was present.

Pressure was high over Lake Superior and low over New Brunswick.

July 16, 1908.—Seven kites were used; lifting surface, 45.1 sq. m. Wire out, 8,839 m., at maximum altitude.

During most of the flight a few Ci. were visible moving from the west. A few Cu. began to form in the southeast about 10 a. m., but soon dissipated.

An extensive area of high pressure was central over Lake Erie, and lows of moderate intensity were over New Brunswick and North Dakota.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m. Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.	At different heights above sea. Height.	Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.
	°C.	%		Meters p. s.	Meters.	°C.	%		Meters p. s.
July 17, 1908:									
7:09 a. m.	18.9	45	sw.	6.7	526	18.9	45	sw.	6.7
7:17 a. m.	18.9	45	s.	6.7	875	19.0	......	s.	......
7:30 a. m.	18.9	45	sw.	6.7	1,129	16.1	......	sw.	......
7:47 a. m.	19.2	46	sw.	6.7	1,569	11.6	......	sw.	......
8:04 a. m.	19.4	47	s.	6.8	1,864	9.8	......	sw.	......
8:24 a. m.	20.0	47	s.	4.9	2,644	10.0	......	wsw.	......
8:48 a. m.	20.2	45	s.	4.0	2,992	8.4	......	w.	......
9:16 a. m.	20.4	48	s.	5.4	3,531	4.6	......	w.	......
9:31 a. m.	21.1	48	s.	5.4	3,829	1.5	......	w.	......
10:02 a. m.	22.0	50	s.	6.7	3,991	−0.6	......	w.	......
10:40 a. m.	22.8	50	s.	7.2	4,304	−2.0	......	w.	......
11:17 a. m.	23.9	44	s.	7.2	3,899	−0.4	......	w.	......
12:20 p. m.	24.9	43	s.	7.2	3,272	7.5	......	w.	......
12:40 p. m.	25.0	43	sw.	8.0	2,664	9.5	......	n.	......
1:22 p. m.	25.8	45	sw.	7.2	2,057	18.0	......	sw.	......
1:33 p. m.	25.6	45	s.	7.6	1,664	18.0	......	sw.	......
1:47 p. m.	26.1	44	s.	8.0	1,210	17.0	......	ssw.	......
2:06 p. m.	25.9	44	sw.	8.5	831	21.5	......	s.	......
2:11 p. m.	26.1	44	s.	8.5	526	26.1	44	s.	8.5
July 18, 1908:									
7:00 a. m.	23.2	69	w.	8.9	526	23.2	69	w.	8.9
7:11 a. m.	23.8	68	w.	8.0	964	22.1	......	w.	......
7:22 a. m.	23.4	69	w.	7.6	1,408	20.0	......	w.	......
7:36 a. m.	22.9	69	w.	8.5	1,897	16.0	......	w.	......
7:55 a. m.	24.2	68	w.	8.5	2,212	14.2	......	w.	......
8:14 a. m.	23.5	69	w.	8.0	2,608	9.2	......	w.	......
8:38 a. m.	23.4	68	sw.	6.8	3,283	4.5	......	w.	......
8:50 a. m.	23.9	67	w.	7.2	3,869	0.4	......	w.	......
9:35 a. m.	24.7	67	w.	6.8	4,432	−3.1	......	w.	......
10:10 a. m.	25.0	65	sw.	5.8	3,906	−1.0	......	w.	......
10:32 a. m.	25.4	62	w.	6.7	3,378	1.2	......	w.	......
11:10 a. m.	24.9	67	w.	8.0	2,408	9.4	......	w.	......
11:26 a. m.	25.0	67	sw.	5.8	1,961	12.5	......	w.	......
11:43 a. m.	25.4	65	sw.	5.4	1,384	16.5	......	w.	......
11:55 a. m.	25.0	67	sw.	5.4	977	20.4	......	wsw.	......
12:01 p. m.	25.0	69	sw.	5.4	526	25.0	69	sw.	5.4

July 17, 1908.—Six kites were used; lifting surface, 32.0 sq. m. Wire out, 8,230 m.; at maximum altitude, 7,620 m.

From 4/10 to 6/10 Ci. moving from the west were visible during the flight.

A low was central over Lake Michigan. High pressure prevailed over the Atlantic and Gulf States.

July 18, 1908.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 7,620 m.; at maximum altitude, 6,706 m.

The clouds, moving from the west, increased from 7/10 A.-Cu. at the beginning to 10/10 A.-Cu. by the end of the flight. The base of the cloud layer was about 3,962 m. above sea-level. Light rain fell between 11:21 and 11:26 a. m.

An extensive area of low pressure was central over Ontario. Pressure was high over Montana and Wyoming.

RESULTS OF CAPTIVE BALLOON ASCENSION.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
July 20, 1908:									
2:37 p. m.	27.2	42	s.	2.2	526	27.2	42	s.	2.2
2:55 p. m.	27.6	43	se.	2.2	1,081	22.1	......	s.	....
3:07 p. m.	27.8	44	se.	2.7	1,770	15.8	......	wsw.	....
3:13 p. m.	26.9	47	s.	2.7	1,930	12.9	......	wsw.	....
3:38 p. m.	26.3	49	s.	2.2	1,495	17.2	......	wsw.	....
3:51 p. m.	25.8	50	se.	1.8	1,284	19.8	......	ssw.	....
4:04 p. m.	26.7	50	s.	2.7	1,080	21.0	......	sse.	....
4:15 p. m.	26.5	51	s.	2.2	725	24.6	......	s.	....
4:20 p. m.	26.4	51	se.	2.2	526	26.4	51	se.	2.2

RESULTS OF KITE FLIGHTS.

July 21, 1908:									
7:15 a. m	18.7	92	se.	4.0	526	18.7	92	se.	4.0
7:25 a. m	18.9	90	se.	4.0	836	18.6	......	sse.	....
7:37 a. m	19.0	94	se.	3.1	1,241	19.5	......	sse.	....
8:10 a. m	19.4	90	se.	4.5	1,559	19.6	......	sw.	....
9:35 a. m	21.1	88	se.	4.9	1,984	14.8	......	sw.	....
10:46 a. m	23.3	82	se.	5.4	1,823	16.3	......	sw.	....
11:06 a. m	23.3	82	se.	5.4	1,394	20.4	......	s.	....
11:25 a. m	24.4	78	se.	5.4	1,051	19.5	......	sse.	....
11:35 a. m	25.0	75	se.	5.4	800	20.5	......	se.	....
11:40 a. m	24.7	75	se.	5.4	526	24.7	75	se.	5.4

RESULTS OF CAPTIVE BALLOON ASCENSION.

July 22, 1908:									
3:40 p. m	25.2	66	se.	2.7	526	25.2	66	se.	2.7
3:45 p. m	25.4	68	se.	2.7	1,131	23.7	......	o	....
4:00 p. m	25.1	68	se.	2.7	1,992	14.4	......	w.	....
4:16 p. m	25.4	68	se.	3.1	1,628	16.9	......	w.	....
4:25 p. m	25.7	67	se.	3.1	1,497	18.8	......	w.	....
4:36 p. m	25.7	66	ne.	3.6	1,184	22.4	......	o	....
4:50 p. m	25.6	67	se.	3.6	526	25.6	67	se.	3.6

July 20, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,033 m. From 1/10 to 2/10 Cu. were present moving from the west-southwest.

Pressure was high over the lower Lake region and the Gulf, and low over Manitoba, with secondary depressions over Missouri and Nova Scotia.

July 21, 1908.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 4,572 m.; at maximum altitude, 3,353 m.

The sky was overcast with St. moving from the south-southeast until 8:45 a. m., and was more than half covered thereafter. About 2/10 A.-Cu. from the southwest were visible from 9 to 10 a. m.

High pressure prevailed over the New England coast and the Gulf States and comparatively low pressure over the Great Lakes and the Ohio Valley.

July 22, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,073 m. From 6/10 to 8/10 A.-St. moving from the west, and a few Cu., with no apparent motion, were present during the ascension.

Pressure was high over northwestern Iowa and a trough of low pressure extended along the Atlantic coast, with centers over Quebec and southern Florida.

RESULTS OF CAPTIVE BALLOON ASCENSION.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
July 23, 1908:	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
4:41 p. m	23.0	77	s.	2.7	526	23.0	77	s.	2.7
4:51 p. m	23.3	76	sw.	2.2	1,274	19.8	.....	sse.	....
4:57 p. m	23.6	76	sw.	2.2	1,729	17.3	.....	s.	....
5:17 p. m	23.6	75	se.	1.3	1,200	20.2	.....	se.	....
5:32 p. m	23.3	84	nw.	3.1	830	22.0	.....	s.	....
5:48 p. m	22.5	83	nw.	2.2	526	22.5	83	nw.	2.2

RESULTS OF KITE FLIGHTS.

July 24, 1908:									
7:20 a. m	18.9	95	se.	4.0	526	18.9	95	se.	4.0
7:31 a. m	18.9	100	se.	4.0	885	19.9	......	s.	....
7:48 a. m	19.4	96	se.	4.0	1,098	18.2	......	sw.	....
9:18 a. m	22.1	85	se.	2.7	1,775	16.5	......	wsw.	....
9:26 a. m	22.5	83	se.	3.1	1,540	17.6	......	wsw.	....
9:33 a. m	22.7	80	se.	3.1	1,298	19.0	......	sw.	....
9:39 a. m	22.8	82	se.	3.6	1,128	19.5	......	sw.	....
9:42 a. m	22.8	82	se.	3.6	698	20.0	......	sw.	....
9:44 a. m	22.8	82	se.	3.6	526	22.8	82	se.	3.6
July 25, 1908:									
4:10 p. m	20.0	95	nw.	5.4	526	20.0	95	nw.	5.4
4:38 p. m	19.7	98	w.	4.0	758	18.8	......	w.	....
4:55 p. m	19.3	100	w.	1.8	526	19.3	100	w.	1.8

July 23, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 1,981 m.

The sky was overcast during most of the ascension, the clouds moving from the west. Light rain fell from 4:44 to 4:58 p. m. and from 5:30 p. m. to midnight.

Pressure was high over the Lake region and low over Arizona and northwest Canada.

July 24, 1908.—Five kites were used; lifting surface, 32.0 m. Wire out, 3,048 m.; at maximum altitude, 2,134 m.

From 7/10 to 2/10 A.-Cu. moving from the west-southwest were visible during the flight. About 2/10 St. from the southeast were visible until 9 a. m.

High pressure prevailed over the upper Lakes and comparatively low pressure over Florida.

July 25, 1908.—One kite was used; lifting surface, 6.8 sq. m. Wire out, 426 m.

Light rain fell during the flight.

Pressure was high over New Brunswick and the Lake region and low over the Gulf coast.

RESULTS OF CAPTIVE BALLOON ASCENSION.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
July 27, 1908:									
1:22 p. m	21.1	88	se.	1.3	526	21.1	88	se.	1.3
1:25 p. m	20.4	92	n.	2.2	1,180	19.4	......	nnw.	....
1:37 p. m	20.8	90	n.	1.8	1,562	15.0	......	o	....
1:50 p. m	21.2	90	nw.	1.8	2,129	11.8	......	ne.	....
2:02 p. m	21.3	90	nw.	1.8	2,988	6.4	......	n.	....
2:10 p. m	21.3	88	nw.	1.8	2,487	8.2	......	n.	....
2:27 p. m	21.0	90	nw.	1.8	2,007	10.2	......	nne.	....
2:44 p. m	21.1	90	nw.	1.3	1,712	18.2	......	nne.	....
2:59 p. m	20.4	89	n.	2.2	1,295	16.1	......	ene.	....
3:12 p. m	19.9	93	ne.	1.8	1,039	17.2	......	ene.	....
3:27 p. m	20.7	85	ne.	1.8	814	18,7	......	ene.	....
3:31 p. m	20.8	82	ne.	1.8	526	20.8	82	ne.	1.3

RESULTS OF KITE FLIGHTS.

July 28, 1908:									
1:46 p. m	23.9	64	e.	4.5	526	23.9	64	e.	4.5
2:21 p. m	25.6	58	e.	5.4	1,088	18.8	......	e.	....
2:50 p. m	25.5	57	se.	2.7	1,618	18.0	......	ene.	....
2:56 p. m	25.6	57	se.	2.7	526	25.6	57	se.	2.7

RESULTS OF CAPTIVE BALLOON ASCENSION.

July 28, 1908:									
7:49 p. m	21.1	68	s.	2.7	526	21.1	68	s.	2.7
7:58 p. m	21.1	68	s.	2.7	1,042	19.5	......	se.	....
8:05 p. m	25.6	72	s.	2.7	1,630	14.5	......	e.	....
9:43 p. m	25.6	72	s.	1.8	526	20.6	72	s.	1.8

July 27, 1908.—Two balloons were used; capacity, 51.2 cu. m. Wire out, 2,896 m. The sky was overcast, clouds moving generally from the north. The balloons entered the lowest clouds at an altitude of 1,128 m., but were visible at frequent intervals thruout the ascension. Light rain began at 1:25 p. m. and continued to 3:35 p. m.

Pressure was high over the Lake region and Ohio Valley and relatively low over northwestern Missouri and off the Florida coast.

July 28, 1908.—Three kites were used; lifting surface, 19.4 sq. m. Wire out, 2.150 m.; at maximum altitude, 2,000 m.

Cu. moving from the east diminished from 9/10 to 3/10 during the flight.

Balloon ascension:

Two balloons were used; capacity, 51.2 cu. m. Wire out, 3,505.

A few Ci. near the horizon were visible during the early part of the ascension.

At 8 a. m. high pressure prevailed over the eastern half of the country. A slight barometric depression was central off the eastern coast of Florida.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
July 29, 1908:									
6:14 a. m	19.7	88	e.	4.0	526	19.7	88	e.	4.0
6:41 a. m	20.0	89	e.	3.6	923	19.1	......	e.	....
7:06 a. m	20.6	89	se.	3.6	1,329	17.6	......	ese.	....
7:20 a. m	20.5	87	e.	3.6	1,814	12.8	......	ese.	....
7:40 a. m	21.3	86	e.	3.6	2,294	9.7	......	ese.	....
7:52 a. m	21.2	83	e.	4.5	2,498	9.2	......	ese.	....
8:00 a. m	21.4	88	e.	4.5	526	21.4	88	e.	4.5
2d flight.									
1:38 p. m	23.9	77	e.	4.5	526	23.9	77	e.	4.5
2:00 p. m	24.4	68	se.	5.4	863	20.9	......	ese.	....
2:44 p. m	24.4	74	se.	5.4	1,812	17.2	......	ese.	....
3:04 p. m	24.4	71	se.	5.8	827	20.4	......	e.	....
3:18 p. m	24.6	70	se.	5.4	526	24.6	70	se.	5.4
July 30, 1908:									
8:48 a. m	21.1	81	s.	4.9	526	21.1	81	s.	4.9
9:00 a. m	21.6	79	s.	4.5	875	18.2	......	ene.	....
9:12 a. m	21.8	79	s.	4.9	1,282	16.7	......	ene.	....
9:26 a. m	22.5	79	e.	5.4	1,778	14.0	......	ene.	....
9:47 a. m	21.8	84	e.	4.5	2,133	11.1	......	e.	....
10:08 a. m	22.6	82	e.	5.4	2,943	8.2	......	e.	....
10:30 a. m	22.1	81	e.	4.5	3,143	10.5	......	e.	....
11:56 a. m	22.8	82	e.	4.5	3,489	7.5	......	e.	....
12:45 p. m	23.9	78	e.	4.5	3,019	10.9	......	e.	....
1:08 p. m	23.9	75	ne.	4.9	2,918	8.4	......	e.	....
1:50 p. m	24.8	70	e.	4.9	2,707	11.8	......	e.	....
2:16 p. m	24.8	71	e.	4.0	2,107	13.0	......	e.	....
2:32 p. m	24.7	68	e.	4.9	1,638	15.0	......	e.	....
2:51 p. m	24.3	71	e.	4.9	1,222	17.6	......	e.	....
3:09 p. m	24.6	66	e.	5.4	898	21.3	......	e.	....
3:20 p. m	24.4	66	e.	5.4	526	24.4	66	e.	5.4

July 29, 1908.—Three kites were used; lifting surface, 23.8 sq. m. Wire out, 3,050 m., at maximum altitude.

From 1/10 to 8/10 St.-Cu. moving from the east were observed during the flight. The base of the cloud layer was about 914 m. above sea-level.

Second flight: Three kites used; lifting surface, 19.4 sq. m. Wire out, 1,600 m.; at maximum altitude, 1,000 m.

From 5/10 to 7/10 Cu. moving from the east were present during the flight.

At 8 a. m. pressure was high over Massachusetts and low over North Dakota.

July 30, 1908.—Six kites were used; lifting surface, 38.3 sq. m. Wire out, 7,000 m., at maximum altitude.

At the beginning of the flight 7/10 Ci. were present moving from the southwest. St.-Cu. appeared about 9 a.m. moving from the east-northeast, and by 10:30 had covered the sky and their direction had shifted from east-northeast to east. The sky remained nearly overcast till 1 p. m. after which time both Ci. and St.-Cu. decreased slowly in amount. The leading kite past above the base of the St.-Cu. at 9:10 a. m., altitude about 1,219 m., and remained above until 1:50 p. m., frequently visible in rifts between the clouds.

A low of considerable energy was off the Carolina coast, and depressions of less intensity were over Lake Superior, the mouth of the Mississippi River, and the mouth of the St. Lawrence. A high central over South Dakota overlay western districts and extended eastward in a ridge to southern New England.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.					
	Air temperature.	Rel. hum.								
	° C.	%		p. s.	Meters.	° C.	%			p. s.
July 31, 1908:										
6:55 a. m.	19.3	96	ne.	3.6	526	19.3	96	ne.		3.6
7:10 a. m.	19.2	94	ne.	5.4	854	20.0	......	ene.		......
7:20 a. m.	19.4	94	ne.	5.4	1,286	17.5	......	ene.		......
7:40 a. m.	19.4	94	ne.	4.9	1,707	14.8	......	ene.		......
8:04 a. m.	19.9	95	ne.	2.7	2,177	12.5	......	ene.		......
8:35 a. m.	20.6	94	ne.	4.9	2,904	[illegible]	......	ene.		......
8:39 a. m.	21.4	88	ne.	6.3	3,680	7.0	......	ene.		......
9:40 a. m.	22.6	82	ne.	5.4	4,158	2.4	......	ene.		......
12:10 p. m.	24.4	74	ne.	5.4	4,992	− 2.8	......	ne.		......
2:20 p. m.	25.6	71	ne.	5.4	5,299	− 3.0	......	ne.		......
3:56 p. m.	25.3	70	ne.	4.5	4,187	1.7	......	ne.		......
4:20 p. m.	24.6	69	ne.	3.1	3,827	6.4	......	ne.		......
5:00 p. m.	24.4	70	ne.	3.1	2,977	8.1	......	nne.		......
5:20 p. m.	23.9	74	ne.	3.6	2,308	13.0	......	nne.		......
5:46 p. m.	22.9	74	ne.	3.6	1,818	15.6	......	nne.		......
6:05 p. m.	23.9	74	ne.	3.6	1,292	18.9	......	nne.		......
6:19 p. m.	22.9	74	ne.	3.1	959	21.5	......	nne.		......
6:29 p. m.	23.3	78	ne.	4.5	526	23.3	78	ne.		4.5
August 1, 1908:										
7:05 a. m.	19.3	94	nw.	8.0	526	19.3	[illegible]	nw.		8.0
7:20 a. m.	19.5	91	nw.	8.0	761	16.5	......	nw.		......
7:36 a. m.	20.0	89	nw.	8.5	1,363	18.6	......	nnw.		......
7:46 a. m.	20.1	87	nw.	7.6	1,782	17.2	......	nnw.		......
8:06 a. m.	20.8	81	nw.	10.8	2,268	14.6	......	nnw.		......
9:00 a. m.	20.1	70	nw.	10.7	3,045	8.0	......	n.		......
9:15 a. m.	20.3	70	nw.	10.7	3,659	5.0	......	n.		......
9:50 a. m.	20.7	68	nw.	10.8	4,508	0.1	......	n.		......
10:16 a. m.	20.6	64	nw.	13.0	5,072	− 5.0	......	n.		......
10:47 a. m.	21.1	63	nw.	10.7	5,876	− 9.1	......	n.		......
12:50 p. m.	22.9	61	n.	8.9	6,062	−16.6	......	n.		......
2:10 p. m.	24.3	47	nw.	8.9	5,788	−13.7	......	n.		......
2:48 p. m.	24.7	47	nw.	8.9	526	24.7	47	nw.		8.9

July 31, 1908.—Twelve kites were used; lifting surface, 77.1 sq. m. Wire out, 12,100 m.; at maximum altitude, 10,300 m.

Light fog prevailed until 7:30 a. m. From 10/10 to 2/10 St. moving from the northeast were visible until 4 p. m., except between 12:25 p. m. and 2:16 p. m., when light rain was falling from nimbus clouds. From 2/10 to 9/10 Ci. from the southwest were visible after 2:30 p. m.

High pressure prevailed over the Mississippi Valley. Lows were central over the lower St. Lawrence and the Carolina coast.

August 1, 1908.—Nine kites were used; lifting surface, 58.2 sq. m. Wire out, 13,500 m.; at maximum altitude, 12,000 m.

At the beginning 9/10 Ci.-St. moving from the southwest were observed. By 7:40 a. m. these had given place to 7/10 A.-St. moving from the southwest, and a few St.-Cu. from the northwest. About 4/10 A.-St. moving from the southwest were visible after 9:15 a. m. A solar halo was seen from 6:45 to 7:10 a. m. A few low St. moving from the northwest past under the head kite at an altitude of 100 m.

A storm was central off the Virginia coast, and a ridge of high pressure extended from Lake Huron to Colorado.

RESULTS OF CAPTIVE BALLOON ASCENSION.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
August 3, 1908:	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
1:40 p. m.	27.1	57	e.	1.8	526	27.1	57	e.	1.8
1:55 p. m.	28.3	56	nw.	1.8	1,166	22.6	......	o	....
2:08 p. m.	27.8	56	se.	1.3	1,740	18.2	......	wnw.	....
2:28 p. m.	27.7	55	s.	1.8	2,264	16.2	......	nw.	....
2:33 p. m.	27.8	55	se.	1.8	1,789	18.2	......	wnw.	....
2:50 p. m.	28.8	56	s.	1.8	1,394	21.0	......	w.	....
3:14 p. m.	28.5	56	s.	2.2	1,063	24.6	......	sse.	....
3:21 p. m.	28.3	55	s.	2.2	801	26.6	......	sse.	....
3:25 p. m.	28.3	56	s.	2.2	526	28.3	56	s.	2.2

RESULTS OF KITE FLIGHTS.

August 4, 1908:									
7:16 a. m.	23.5	77	w.	6.3	526	23.5	77	w.	6.3
7:53 a. m.	23.9	74	w.	6.3	1,140	23.8	......	wnw.	....
8:46 a. m.	25.6	69	w.	4.5	526	25.6	69	w.	4.5

RESULTS OF CAPTIVE BALLOON ASCENSION.

August 4, 1908:									
2:14 p. m.	31.1	50	s.	3.6	526	31.1	50	s.	3.6
2:25 p. m.	31.1	37	s.	2.7	1,335	23.8	......	ssw.	....
2:37 p. m.	31.1	39	se.	3.1	2,329	18.2	......	w.	....
3:02 p. m.	31.1	39	se.	2.2	1,787	20.1	......	sw.	....
3:11 p. m.	30.9	42	se.	2.2	1,284	25.0	......	s.	....
3:31 p. m.	31.1	46	se.	2.7	526	31.1	46	se.	2.7

August 3, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,256 m. About 2/10 Ci. and a few Cu. were present, moving from the northwest.

Pressure was high over the Atlantic coast States, and low over the Mississippi Valley and the upper Lake region.

August 4, 1908.—Kite flight: Three kites were used; lifting surface, 19.4 sq. m. Wire out, 1,676 m; at maximum altitude the same.

A few Ci. near the horizon were visible during the early part of the flight.

Balloon ascension:

One balloon was used; capacity, 25.6 cu. m. Wire out, 2,347 m.

A few Cu. were visible near the horizon.

At 8 a. m. high pressure prevailed over the Atlantic coast States. A low was central over southern Manitoba.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m. Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.	At different heights above sea. Height.	Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.
	°C.	%		Meters p. s.	Meters.	°C.	%		Meters p. s.
August 5, 1908:									
2:02 p. m.	21.5	92	sw.	4.9	526	21.5	92	sw.	4.9
2:15 p. m.	21.9	91	sw.	5.4	884	20.8	......	wnw.	....
2:30 p. m.	22.4	82	sw.	5.4	1,254	19.5	......	w.	....
2:40 p. m.	22.7	79	w.	5.4	1,537	17.7	......	w.	....
3:00 p. m.	21.3	74	sw.	5.4	1,818	15.5	......	w.	....
3:29 p. m.	23.4	74	w.	6.3	1,951	15.1	......	sw.	....
3:35 p. m.	23.4	74	w.	6.3	2,396	12.2	......	sw.	....
4:46 p. m.	24.2	74	w.	5.8	3,192	9.8	......	nw.	....
5:04 p. m.	23.5	77	w.	5.8	2,618	12.1	......	w.	....
5:20 p. m.	24.2	75	w.	4.9	1,753	18.1	......	w.	....
5:30 p. m.	23.4	78	w.	4.0	1,514	17.8	......	w.	....
5:45 p. m.	22.9	81	w.	3.6	704	20.7	......	w.	....
5:50 p. m.	22.8	82	sw.	3.6	526	22.8	82	sw.	3.6

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Date and hour.	Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.
August 6, 1908:									
1:25 p. m.	24.4	80	se.	1.8	526	24.4	80	se.	1.8
1:29 p. m.	24.3	80	s.	2.2	1,227	20.9	......	w.	....
1:43 p. m.	24.4	82	s.	2.2	1,786	17.2	......	nw.	....
2:05 p. m.	23.9	80	s.	2.7	1,422	19.8	......	nw.	....
2:35 p. m.	24.7	81	se.	2.7	1,122	21.6	......	wsw.	....
2:42 p. m.	24.8	80	s.	2.7	841	22.9	......	wsw.	....
2:50 p. m.	24.2	80	s.	2.7	526	24.2	80	s.	2.7

August 5, 1908.—Six kites were used; lifting surface, 38.8 sq. m. Wire out, 5,334 m.; at maximum altitude, 3,962 m.

Light rain prevailed at the beginning and continued until 3:15 p. m. From 3/10 to 8/10 A.-St. and a few Cu. moving from the west were present during the remainder of the flight.

Pressure was high over the Georgia and Carolina coasts and low over the Lake region.

August 6, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,134 m.

During most of the ascension the sky was from 5/10 to 9/10 covered with A.-Cu. moving from the west and Cu. moving from the southwest, shifting to south. Lower clouds were increasing rapidly when the balloon was landed. A thunderstorm, accompanied by excessive precipitation and high winds, past over the station from the northwest, rain falling from 3:25 to 4:10 p. m.

Pressure was low over Ontario and high over Manitoba.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
August 7, 1908:	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
7:22 a. m.	23.3	79	w.	5.4	526	23.3	79	w.	5.4
7:30 a. m.	23.8	79	w.	6.3	924	23.0	......	w.	....
7:45 a. m.	22.5	78	w.	5.4	1,348	19.5	......	w.	....
7:55 a. m.	22.8	78	w.	5.4	1,727	17.4	......	w.	....
8:10 a. m.	22.8	76	w.	4.5	2,116	15.2	......	w.	....
8:36 a. m.	23.3	73	w.	4.0	2,348	13.7	......	w.	....
8:50 a. m.	23.6	72	w.	3.6	3,078	9.0	......	w.	....
9:30 a. m.	23.9	70	w.	4.9	4,459	1.1	......	wsw.	....
10:10 a. m.	24.4	67	w.	4.0	3,968	3.1	......	wsw.	....
10:23 a. m.	24.4	70	w.	3.6	3,727	3.1	......	w.	....
10:40 a. m.	24.4	67	w.	3.6	3,352	5.5	......	wsw.	....
11:00 a. m.	24.4	70	w.	2.7	2,687	10.8	......	wsw.	....
11:15 a. m.	24.4	70	w.	2.7	2,093	13.5	......	w.	....
11:30 a. m.	24.3	70	sw.	2.7	1,793	16.0	......	w.	....
11:44 a. m.	25.4	68	sw.	2.7	526	25.4	68	sw.	2.7
August 8, 1908:									
7:03 a. m.	16.0	85	nw.	4.9	526	16.0	84	nw.	4.9
7:16 a. m.	17.2	79	nw.	5.4	870	14.0	......	nw.	....
7:30 a. m.	16.3	87	nw.	5.4	1,204	13.4	......	nw.	....
7:44 a. m.	16.7	84	nw.	5.4	1,478	10.8	......	nw.	....
8:03 a. m.	17.4	84	nw.	6.3	1,624	10.8	......	nw.	....
9:00 a. m.	18.2	71	nw.	7.6	1,493	14.8	......	n.	....
9:33 a. m.	18.4	69	nw.	7.6	1,170	15.9	......	n.	....
9:42 a. m.	18.4	64	nw.	8.0	784	18.9	......	n.	....
10:21 a. m.	19.2	66	nw.	7.2	526	19.2	66	nw.	7.2

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

August 10, 1908:									
1:33 p. m.	22.6	61	ne.	0.9	526	22.6	61	ne.	0.9
1:45 p. m.	22.5	60	se.	0.9	1,288	19.3	......	o	....
1:54 p. m.	22.8	61	se.	1.8	2,280	10.6	......	sw.	....
2:05 p. m.	22.5	66	sw.	2.2	1,811	12.0	......	sw.	....
2:26 p. m.	23.3	65	sw.	1.8	1,618	14.0	......	sw.	....
2:37 p. m.	22.6	63	sw.	1.8	1,365	15.7	......	sw.	....
2:45 p. m.	23.1	63	s.	1.8	1,105	17.3	......	ssw.	....
2:53 p. m.	21.8	69	nw.	1.8	844	19.9	......	sw.	....
2:56 p. m.	21.9	62	nw.	1.8	526	21.9	62	nw.	1.8

August 7, 1908.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 6,096 m.; at maximum altitude, 5,791 m.

From 6/10 to 9/10 Ci. moving from the west were visible during the flight.

A low was central over northern Virginia. High pressure prevailed over the western half of the country.

August 8, 1908.—Five kites were used; lifting surface, 38.3 sq. m. Wire out, 3,901 m.; at maximum altitude, 2,286 m.

About 8/10 of the sky was covered with Ci.-St., A.-Cu., and St.-Cu. until 8 a. m. Thereafter the sky was partly covered with A.-Cu. until 9 a. m. and with Ci.-St. and A.-Cu. until the end. All clouds were moving from the west.

Low pressure was central over the lower St. Lawrence, with secondary depressions over Cape Hatteras and Tennessee. Centers of high pressure lay over Wisconsin and Kansas.

August 10, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,316 m. The sky was about 8/10 covered with clouds of cumulus formation, moving from the southwest at their bases, the tops moving from the northwest where visible. The balloon entered the base of the clouds at an altitude of about 1,800 m. Light rain fell from 2:55 to 3:10 p. m.

Pressure was high over West Virginia and low over the lower St. Lawrence.

RESULTS OF CAPTIVE BALLOON ASCENSION.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
August 11, 1908:									
2:04 p. m.	26.1	50	sw.	2.7	526	26.1	50	sw.	2.7
2:12 p. m.	26.1	50	sw.	3.1	2,012	18.5	......	w.	....
2:22 p. m.	26.1	50	sw.	3.1	1,871	18.4	......	w.	....
2:30 p. m.	25.6	50	sw.	4.5	1,208	19.7	......	wsw.	....
2:52 p. m.	25.0	52	w.	4.0	526	25.0	52	w.	4.0
August 12, 1908:									
10:47 a. m.	27.2	62	s.	2.7	526	27.2	62	s.	2.7
10:55 a. m.	26.5	62	s.	2.7	1,815	15.9	......	w.	....
11:24 a. m.	26.7	57	sw.	2.7	904	22.1	......	ssw.	....
11:32 a. m.	26.7	57	sw.	1.7	526	26.7	57	sw.	2.7

RESULTS OF KITE FLIGHTS.

August 13, 1908:									
7:06 a. m.	23.9	63	w.	5.8	526	23.9	63	w.	5.8
7:15 a. m.	24.2	63	sw.	6.3	875	23.7	......	wsw.	....
7:24 a. m.	24.2	63	w.	6.8	1,088	21.5	......	wsw.	....
7:33 a. m.	23.8	63	w.	6.7	1,371	19.1	......	w.	....
7:48 a. m.	23.9	63	w.	7.6	1,756	16.0	......	w.	....
8:08 a. m.	24.8	64	w.	8.5	2,874	10.0	......	wsw.	....
8:56 a. m.	25.2	60	w.	7.2	2,975	4.4	......	wsw.	....
9:18 a. m.	25.9	60	nw.	6.8	3,166	3.5	......	wsw.	....
9:21 a. m.	26.0	60	w.	5.8	3,705	4.6	......	wsw.	....
9:27 a. m.	26.1	60	sw.	4.9	3,942	3.5	......	wsw.	....
9:31 a. m.	26.1	60	sw.	4.9	3,708	5.0	......	wsw.	....
10:06 a. m.	26.9	59	sw.	5.8	3,108	2.8	......	wsw.	....
11:46 a. m.	27.8	52	sw.	5.8	2,688	8.0	......	sw.	....
12:02 p. m.	28.6	55	sw.	5.4	2,132	12.8	......	sw.	....
12:20 p. m.	27.9	54	sw.	5.8	1,561	18.4	......	wsw.	....
12:28 p. m.	28.9	52	sw.	5.4	1,040	23.2	......	wsw.	....
12:41 p. m.	28.9	49	sw.	5.4	526	28.9	49	sw.	5.4

August 11, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,347 m. From 1/10 to 2/10 Cu. moving from the west were visible during the ascension. High pressure, slightly lower over northern Virginia than elsewhere, prevailed over the eastern half of the country.

August 12, 1908.—One balloon was used; capacity, 25.6 cu. m.

About 1/10 St. moving from the west was visible during the flight.

A low was central over eastern Wisconsin; high pressure prevailed along the Atlantic coast.

August 13, 1908.—Seven kites were used; lifting surface, 44.6 sq. m. Wire out, 7,010 m.; at maximum altitude, 5,639 m.

A few Ci. appeared at 8:40 a. m. moving from the west, and had increased to 7/10 by 11:40 a. m. A few Cu. were visible after 12:20 p. m. moving from the west.

Pressure was low over Quebec and high off the Carolina coast.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
August 14, 1908:									
7:19 a. m.	23.3	75	w.	4.5	526	23.3	75	w.	4.5
7:41 a. m.	22.8	80	nw.	5.4	1,027	19.5	......	nw.	....
8:10 a. m.	22.8	76	nw.	5.8	1,442	20.5	......	nw.	....
9:12 a. m.	23.6	78	nw.	5.8	1,859	16.5	......	nw.	....
10:13 a. m.	25.3	73	nw.	5.8	2,153	14.5	......	wnw.	....
10:22 a. m.	25.3	71	nw.	4.9	1,600	18.8	......	nw.	....
10:57 a. m.	25.3	71	nw.	6.3	1,007	19.6	......	nw.	....
11:05 a. m.	25.6	71	nw.	6.3	887	22.0	......	wnw.	....
11:18 a. m.	25.0	71	nw.	6.3	526	25.0	71	nw.	6.3
August 15, 1908:									
7:11 a. m.	22.1	69	nw.	3.1	526	22.1	69	nw.	3.1
7:20 a. m.	22.2	69	nw.	3.1	828	23.6	......	n.	....
7:34 a. m.	22.3	71	nw.	3.1	1,068	21.9	......	n.	....
8:45 a. m.	22.8	73	nw.	3.6	1,451	17.5	......	nne.	....
9:05 a. m.	23.3	74	nw.	3.1	1,891	13.8	......	nnw.	....
7:37 a. m.	23.9	70	nw.	3.6	1,348	19.5	......	nnw.	....
9:48 a. m.	23.9	70	nw.	3.6	1,242	20.4	......	nnw.	....
9:54 a. m.	24.3	74	nw.	3.1	778	21.7	......	n.	....
9:58 a. m.	23.6	70	nw.	2.7	526	23.6	70	nw.	2.7
August 17, 1908:									
1:42 a. m.	28.3	72	s.	4.5	526	28.3	72	s.	4.5
2:02 a. m.	28.4	73	s.	4.5	902	23.6	......	ssw.	....
2:15 a. m.	28.4	75	s.	4.5	1,164	24.2	......	sw.	....
2:31 a. m.	27.2	77	s.	4.5	1,263	22.4	......	sw.	....
2:47 a. m.	25.6	78	ne.	4.9	1,733	17.2	......	sw.	....
2:57 a. m.	23.9	72	n.	7.6	948	20.6	......	nne.	....
3:01 a. m.	23.6	71	ne.	7.2	526	23.6	71	ne.	7.2

August 14, 1908.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 4,115 m.; at maximum altitude, 2,591 m.

From 1/10 to 7/10 A.-Cu. were visible moving from the west. After 9:30 a. m. a few Cu. from the northwest were also visible.

A high was central over North Carolina and a low over the lower St. Lawrence Valley.

August 15, 1908.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 3,048 m.; at maximum altitude, 2,591 m.

The sky was partly covered with Ci.-Cu. and A.-Cu. moving from the west-southwest until 8:45 a. m. At 9 a. m. a few Ci. were moving from the northwest and 1/10 A.-Cu. from the west-southwest. About 2/10 Ci.-St. from the northwest were visible after 9:30 a. m.

High pressure, central north of Lake Huron, extended over the eastern United States.

August 17, 1908.—Three kites were used; lifting surface, 19.4 sq. m. Wire out, 1,737 m.; at maximum altitude, 1,402 m.

At the beginning 1/10 Ci. moving from the west-northwest and 6/10 Cu. moving from the southwest were observed. Distant thunder was heard to the northwest. About 2:40 p. m. a thunder-storm past near the station to the north. At 2:45 p. m. surface winds shifted from south to northeast and became brisk, and low clouds moving from the north past over the station at an altitude of about 914 m. At 3:15 p. m. these low clouds had disappeared and the surface winds had returned to southerly. Light rain fell from 3:55 to 4:25 p. m., and excessive precipitation, accompanied by frequent lightning, occurred from 5:55 to 6:12 p. m. and from 7:14 to 7:30 p. m.

Pressure was high off the New England coast and over South Atlantic States and low over Ontario.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
August 18, 1908:									
7:19 a. m.	20.0	90	nw.	4.9	526	20.0	90	nw.	4.9
7:24 a. m.	20.0	90	nw.	4.9	765	17.5	......	nw.	....
7:39 a. m.	20.2	90	nw.	4.9	1,009	16.5	......	nnw.	....
7:51 a. m.	20.6	90	nw.	5.4	1,286	15.5	......	nnw.	....
8:08 a. m.	20.8	87	nw.	5.4	1,708	13.8	......	nw.	....
8:30 a. m.	21.1	88	nw.	5.8	2,173	10.7	......	wnw.	....
8:49 a. m.	21.2	89	nw.	5.4	2,884	6.1	......	wnw.	....
9:02 a. m.	21.7	86	nw.	5.4	3,291	4.0	......	wnw.	....
9:30 a. m.	22.2	85	nw.	7.2	3,658	2.9	......	wnw.	....
9:59 a. m.	22.3	86	nw.	6.8	4,352	− 1.1	......	wnw.	....
10:42 a. m.	23.1	82	nw.	4.9	3,718	2.1	......	wnw.	....
11:07 a. m.	23.3	82	nw.	4.9	3,284	7.2	......	wnw.	....
11:31 a. m.	23.9	78	nw.	4.9	2,098	13.1	......	wnw.	....
11:46 a. m.	24.4	74	nw.	4.5	1,630	15.0	......	wnw.	....
11:58 a. m.	25.0	74	nw.	5.4	1,266	17.0	......	wnw.	....
12:14 p. m.	25.0	71	nw.	5.4	526	25.0	71	nw.	5.4
August 19, 1908:									
1:54 p. m.	27.2	39	nw.	7.2	526	27.2	39	nw.	7.2
2:05 p. m.	27.2	39	nw.	6.3	958	23.2	......	w.	....
2:33 p. m.	27.3	42	w.	6.7	1,337	19.1	......	wsw.	....
2:45 p. m.	27.8	40	nw.	7.2	1,726	14.0	......	wsw.	....
3:06 p. m.	27.6	40	nw.	5.8	2,096	11.8	......	w.	....
3:23 p. m.	27.8	40	nw.	4.9	2,725	8.2	......	wnw.	....
3:45 p. m.	27.8	41	nw.	7.6	3,213	2.9	......	wnw.	....
4:00 p. m.	27.6	38	nw.	6.3	3,872	− 0.5	......	wnw.	....
4:18 p. m.	27.3	39	nw.	5.8	4,223	− 3.4	......	wnw.	....
4:40 p. m.	27.2	40	nw.	4.9	4,303	− 2.3	......	wnw.	....
5:10 p. m.	27.2	37	nw.	4.5	3,596	1.7	......	wnw.	....
5:33 p. m.	27.2	43	nw.	3.6	2,782	6.4	......	wnw.	....
5:54 p. m.	26.1	41	nw.	4.5	2,175	11.2	......	w.	....
6:18 p. m.	25.4	44	nw.	4.9	1,464	18.2	......	w.	....
6:24 p. m.	25.0	42	nw.	5.4	944	23.3	......	w.	....
6:29 p. m.	24.8	40	nw.	6.3	526	24.8	40	nw.	6.3

August 18, 1908—Six kites were used; lifting surface, 38.3 m. Wire out, 7,620 m.; at maximum altitude, 7,468 m.

From 1/10 to 6/10 Ci. moving from the northwest were visible until 9:30 a. m. Low St. from the northwest were visible at intervals during the flight.

A high was central over eastern Iowa and a low over the lower St. Lawrence Valley.

August 19, 1908.—Seven kites were used; lifting surface, 44.6 sq. m. Wire out, 8,382 m.; at maximum altitude, 7,620 m.

Ci.-St. moving from the west-northwest decreased from 2/10 at the beginning to a few at the end; and a few Cu. moving from the west were visible all thru the flight.

Low pressure, central over New Brunswick, with a secondary depression over this station, covered the eastern and southern United States.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
August 20, 1908:	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
7:33 a. m.	14.2	88	nw.	8.0	526	14.2	88	nw.	8.0
7:45 a. m.	14.3	87	nw.	8.0	837	11.2	......	nnw.	....
7:52 a. m.	14.4	85	nw.	9.0	940	12.8	......	nnw.	....
8:48 a. m.	15.0	84	nw.	7.2	2,641	5.8	......	wnw.	....
9:12 a. m.	16.4	77	nw.	7.2	3,317	0.4	......	wnw.	....
9:50 a. m.	16.7	75	nw.	5.4	3,985	— 1.2	......	wnw.	....
10:17 a. m.	16.9	68	nw.	6.7	4,661	— 6.7	......	w.	....
10:40 a. m.	16.2	66	nw.	5.4	4,029	— 3.2	......	w.	....
11:35 a. m.	18.3	59	nw.	5.4	3,621	0.4	......	wnw.	....
11:54 a. m.	19.2	57	n.	4.9	3,169	0.8	......	wnw.	....
12:12 p. m.	18.9	55	nw.	4.9	2,592	5.8	......	wnw.	....
12:29 p. m.	18.7	59	nw.	4.9	2,096	11.2	......	wnw.	....
12:40 p. m.	19.2	56	nw.	4.5	1,556	8.0	......	nw.	....
12:52 p. m.	19.1	56	n.	5.4	767	14.0	......	nnw.	....
1:02 p. m.	19.4	53	nw.	5.8	526	19.4	53	nw.	5.8
August 21, 1908:									
9:01 a. m.	16.0	68	se.	4.5	526	16.0	68	se.	4.5
12:22 p. m.	20.2	68	s.	5.4	1,071	14.0	......	ssw.	....
1:00 p. m.	20.7	63	se.	6.3	1,608	14.8	......	sw.	....
1:20 p. m.	21.1	62	s.	5.4	2,407	8.5	......	sw.	....
2:27 p. m.	21.7	60	s.	5.4	2,819	5.4	......	sw.	....
3:00 p. m.	21.7	60	s.	6.3	3,808	3.0	......	sw.	....
3:38 p. m.	20.6	64	s.	5.4	3,952	— 0.6	......	wsw.	....
4:06 p. m.	20.0	67	s.	5.4	3,196	2.3	......	wsw.	....
4:35 p. m.	19.4	70	s.	5.4	2,652	6.6	......	wsw.	....
5:12 p. m.	19.4	71	se.	4.5	2,097	10.4	......	sw.	....
5:28 p. m.	18.9	76	se.	4.5	1,870	11.4	......	sw.	....
5:40 p. m.	18.4	76	se.	5.8	1,578	13.1	......	ssw.	....
5:49 p. m.	18.3	75	s.	5.4	1,123	15.5	......	ssw.	....
5:57 p. m.	18.1	76	s.	6.3	821	15.1	......	s.	....
6:03 p. m.	17.8	82	s.	7.6	526	17.8	82	s.	7.6

RESULTS OF CAPTIVE BALLOON ASCENSION.

August 22, 1908:									
1:52 p. m.	23.4	82	nw.	1.3	526	23.4	82	nw.	1.3
1:58 p. m.	23.6	82	ne.	1.3	1,035	20.3	......	wsw.	....
2:03 p. m.	27.3	82	se.	1.3	1,476	18.0	......	wsw.	....
2:14 p. m.	24.3	80	se.	1.3	830	28.8	......	wsw.	....
3:00 p. m.	23.9	82	se.	1.3	526	23.9	82	se.	1.3

August 20, 1908.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 8,230 m.; at maximum altitude, 7,833 m.

Clouds overcast the sky at the beginning of the flight, diminishing to about 2/10 at the end. Upper clouds were from the west, and the lower from the west-northwest, shifting to northwest. The leading kite was in A.-Cu. at an altitude of 3,400 to 4,000 m., and in Cu. at altitude, 1,556 m.

Pressure was low off the North Carolina coast and high over the upper Mississippi Valley.

August 21, 1908.—Seven kites were used; lifting surface, 44.6 sq. m. Wire out, 7,650 m.; at maximum altitude, 7,468 m.

From 1/10 to 5/10 Ci. moving from the west-southwest were visible until 3:38 p. m. From 1/10 to 9/10 St.-Cu. from the southwest were visible from 2:30 p. m. until the end of the flight, except from 5:18 to 5:49 p. m., when light rain was falling.

A high was central over eastern Pennsylvania and a low over Lake Superior.

August 22, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,195 m.

St.-Cu. moving from the west-southwest nearly covered the sky during the ascension.

Low pressure was central north of Lake Ontario. Pressure was high off Nantucket and over Florida.

RESULT OF CAPTIVE BALLOON ASCENSION.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.
August 24, 1908:	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
3:53 p. m.	16.8	76	n.	1.8	526	16.8	76	n.	1.8
3:55 p. m.	16.2	79	n.	1.8	1,117	16.8	......	o	....
4:02 p. m.	16.2	78	n.	1.3	1,434	16.0	......	o	....
4:10 p. m.	16.2	78	n.	1.3	2,261	10.6	......	nw.	....
4:22 p. m.	16.0	80	n.	1.3	1,785	11.8	......	nw.	....
4:45 p. m.	15.6	84	n.	1.8	1,480	15.0	......	wnw.	....
4:50 p. m.	16.2	76	n.	1.8	1,117	18.2	......	o	....
5:04 p. m.	16.2	75	ne.	1.8	526	16.2	75	ne.	1.8

RESULTS OF KITE FLIGHTS.

Date and hour.	Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.
August 25, 1908:									
7:25 a. m.	15.8	72	e.	8.0	526	15.8	72	e.	8.0
7:30 a. m.	15.2	73	se.	8.0	876	13.5	......	se.	....
7:56 a. m.	15.6	68	se.	8.0	1,410	9.6	......	ese.	....
8:25 a. m.	15.6	73	e.	7.6	1,795	8.5	......	ese.	....
10:20 a. m.	14.9	84	se.	7.2	2,076	7.2	......	ese.	....
10:37 a. m.	14.7	84	se.	8.0	2,518	3.9	......	s.	....
11:04 a. m.	14.7	91	se.	6.3	526	14.7	91	se.	6.3
August 26, 1908:									
9:05 a. m.	11.7	100	n.	5.8	526	11.7	100	n.	5.8
9:30 a. m.	11.7	100	n.	4.0	1,151	11.1	......	ne.	....
9:49 a. m.	11.8	100	n.	4.9	1,505	10.1	......	ne.	....
10:10 a. m.	11.9	100	nw.	4.9	1,919	9.8	......	ne.	....
10:54 a. m.	11.8	100	n.	5.4	2,231	8.8	......	ne.	....
11:45 a. m.	12.2	100	n.	3.6	2,378	9.8	......	ne.	....
12:44 p. m.	12.2	100	n.	6.3	1,715	10.8	......	ne.	....
1:08 p. m.	12.2	100	n.	5.8	1,156	13.5	......	ne.	....
1:12 p. m.	12.2	100	n.	6.3	881	11.2	......	nne.	....
1:17 p. m.	12.2	100	n.	5.8	526	12.2	100	n.	5.8

August 24, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,438 m. The sky was overcast with St. moving very slowly from the southeast. The balloon entered the clouds at altitude 1,117 m.

Pressure was high over Lake Superior and moderately low over Alabama.

August 25, 1908.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 7,010 m.; at maximum altitude, 4,276 m.

From 7/10 to 10/10 St.-Cu. moving from the southeast were visible until 10.43 a. m. and 10/10 nimbus thereafter. Light rain fell from 10.43 a. m. until the close of the flight.

A low was central over Georgia. High pressure prevailed over the Great Lakes.

August 26, 1908.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 6,096 m.; at maximum altitude, 5,547 m.

Dense fog prevailed during the flight.

High pressure was central north of the Great Lakes and over New Brunswick. Relatively low pressure lay over Georgia.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m. Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.	At different heights above sea. Height.	Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
August 27, 1908:									
8:45 a. m.	11.7	94	ne.	4.5	526	11.7	94	ne.	4.5
9:01 a. m.	11.8	96	ne.	4.5	857	9.1	......	ne.	....
10:22 a. m.	11.9	96	ne.	3.6	1,340	9.3	......	ne.	....
11:45 a. m.	12.9	97	n.	4.0	1,677	9.7	......	ne.	....
12:30 p. m.	13.2	94	ne.	3.6	2,059	8.9	......	ne.	....
12:45 p. m.	13.2	92	n.	2.7	1,696	8.9	......	ne.	....
12:51 p. m.	13.2	94	n.	2.7	1,163	9.6	......	ne.	....
1:00 p. m.	12.9	96	ne.	2.7	526	12.9	96	ne.	2.7

RESULT OF CAPTIVE BALLOON ASCENSION.

Date and hour.	Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity
August 28, 1908:									
3:57 p. m.	15.0	78	se.	1.8	526	15.0	78	se.	1.8
4:02 p. m.	15.6	75	se.	1.8	1,260	9.5	......	e.	....
4:09 p. m.	15.3	76	se.	2.7	2,106	9.4	......	se.	....
4:30 p. m.	15.1	77	se.	2.2	1,198	12.7	......	se.	....
4:42 p. m.	15.0	78	se.	2.7	1,183	8.7	......	e.	....
4:56 p. m.	15.0	78	se.	2.2	526	15.0	78	se.	2.2
August 29, 1908:									
1:45 p. m.	18.8	62	se.	1.8	526	18.8	62	se.	1.8
1:50 p. m.	18.8	62	se.	1.8	1,287	12.3	......	o	....
2:01 p. m.	18.8	59	s.	1.8	2,144	12.2	......	s.	....
2:15 p. m.	19.1	62	s.	1.8	1,666	7.8	......	se.	....
2:30 p. m.	19.8	61	s.	0.9	1,413	8.9	......	sse.	....
2:50 p. m.	17.9	68	e.	2.2	1,066	11.7	......	o	....
3:05 p. m.	19.2	57	e.	2.2	526	19.2	57	e.	2.2
August 31, 1908:									
3:30 p. m.	23.3	58	se.	3.6	526	23.3	58	se.	3.6
3:38 p. m.	23.3	58	se.	3.1	1,614	16.0	......	ese.	....
3:55 p. m.	23.3	56	se.	2.7	1,079	17.7	......	ese.	....
4:08 p. m.	23.1	56	e.	3.6	799	20.5	......	e.	....
4:19 p. m.	23.3	58	se.	3.1	526	23.3	58	se.	3.1

August 27, 1908.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 2,896 m.; at maximum altitude, 2,591 m.

At the beginning 10/10 St. moving from the northeast were observed. Light mist began 9:10 a. m. and continued during the remainder of the flight. Light fog prevailed from 10:12 to 11:30 a. m. The head kite entered the clouds at 8:54 a. m. at an altitude of 152 m. above the ground.

Pressure was high over the lower St. Lawrence and low over Manitoba. A secondary depression was over the Gulf of Mexico.

August 28, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,027 m.

About 9/10 St.-Cu. moving from the east were visible during the ascension. The balloon disappeared in the clouds at 4:02 p. m. and reappeared at 4:42 p. m.

High pressure prevailed along the New England coast and low pressure over eastern Minnesota, Iowa, and Kansas.

August 29, 1908.—One balloon was used; capacity, 25.6 cu. m. Were out, 2,134 m.

From 5/10 to 7/10 Cu. moving from the south-southeast were observed during the ascension.

High pressure prevailed over the Atlantic coast and low pressure over the Dakotas and Nebraska.

August 31, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,073 m.

The sky was clear.

A ridge of high pressure extended from New Brunswick to southwestern Virginia. Pressure was low over Manitoba.

RESULTS OF CAPTIVE BALLOON ASCENSION.

Date and hour.	On Mount Weather, Va., 526 m. Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.	At different heights above sea. Height.	Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.
September 1, 1908.	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
3:03 p. m	18.9	80	se.	2.7	526	18.0	80	se.	2.7
7:20 p. m	18.9	81	se.	2.7	2,044	11.6	......	wnw.	....
7:37 p. m	18.9	90	se.	8.1	1,787	18.8	......	w.	....
7:47 p. m	18.9	90	se.	2.7	1,480	15.7	......	s.	....
7:58 p. m	18.8	90	se.	8.1	526	18.8	90	se.	8.1

RESULTS OF KITE FLIGHTS.

Date and hour.	Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.
September 2, 1908:									
6:53 a. m	16.4	94	nw.	8.9	526	16.4	94	nw.	8.9
7:18 a. m	17.0	89	nw.	9.8	835	19.1	......	nw.	....
7:27 a. m	17.1	86	nw.	9.8	1,841	16.8	......	wnw.	....
7:39 a. m	16.7	90	nw.	7.6	1,836	14.1	......	wnw.	....
7:50 a. m	16.5	92	nw.	7.2	2,397	9.1	......	w.	....
8:15 a. m	15.6	99	nw.	10.7	3,167	1.6	......	w.	....
9:00 a. m	17.4	91	nw.	8.9	2,462	11.1	......	wnw.	....
9:24 a. m	18.9	84	nw.	8.9	2,071	14.1	......	wnw.	....
9:33 a. m	19.1	84	nw.	8.9	1,865	18.1	......	wnw.	....
9:50 a. m	19.4	81	nw.	7.2	1,472	18.7	......	wnw.	....
10:00 a. m	20.0	80	nw.	8.0	1,095	15.5	......	wnw.	....
10:13 a. m	20.1	77	nw.	9.4	838	16.1	......	wnw.	....
10:18 a. m	20.1	79	nw.	7.6	526	20.1	79	nw.	7.6
September 3, 1908:									
8:59 a. m	12.2	58	nw.	8.0	526	12.2	58	nw.	8.0
9:11 a. m	12.0	65	nw.	8.0	881	8.1	......	nnw.	....
10:37 a. m	14.2	59	nw.	7.6	1,081	6.5	......	nnw.	....
10:51 a. m	14.8	58	nw.	7.6	1,802	12.2	......	nnw.	....
11:20 a. m	14.8	58	nw.	5.8	2,171	9.6	......	nnw.	....
1:18 p. m	16.8	54	nw.	5.8	2,688	7.5	......	nnw.	....
2:15 p. m	18.3	54	nw.	4.0	3,086	5.8	......	nnw.	....
2:55 p. m	18.4	47	nw.	6.3	2,585	7.2	......	nnw.	....
3:12 p. m	18.8	48	nw.	8.6	1,749	12.0	......	nnw.	....
3:18 p. m	18.8	48	nw.	8.6	1,585	7.8	......	nnw.	....
3:24 p. m	18.9	50	nw.	4.0	1,208	11.0	......	nnw.	....
3:31 p. m	19.2	49	nw.	4.5	832	15.0	......	nnw.	....
3:35 p. m	18.6	49	nw.	4.5	526	18.6	49	nw.	4.5

September 1, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,134 m.

The sky was clear at the beginning of the ascension. At 7:30 p. m. low St. began to form, the amount gradually increasing to 8/10 at the close of the ascension.

A ridge of high pressure extended from northern Alabama to the New England coast. A low was central off the Carolina coast.

September 2, 1908.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 4,572 m., at maximum altitude.

The sky was overcast with St. until 8:30 a. m. Thereafter A.-Cu. and St.-Cu. were observed in amounts decreasing from 7/10 at 8:45 to 3/10 at 9:10 a. m. Only 1/10 or less A.-Cu. were visible during the remainder of the flight. All clouds were moving from the west.

High pressure was central over Iowa and low over the lower St. Lawrence.

September 3, 1908.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 4,700 m., at maximum altitude.

A few Cu. moving from the north-northeast were observed during the flight.

Pressure was high over the Lake region and low over Manitoba and New Brunswick.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
						e.	Rel. hum.	Wind. Dir.	Wind. Velocity.
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
September 4, 1908:									
7:16 a. m	15.1	68	sw.	5.4	526	15.1	68	sw.	5.4
7:31 a. m	15.0	68	s.	5.4	796	13.8	......	s.	......
10:00 a. m	17.3	60	s.	4.9	1,285	10.0	......	ssw.	......
10:40 a. m	17.8	56	s.	4.5	1,115	11.5		s.	......
11:09 a. m	18.9	55	s.	[illegible]	526	18.9	55	s.	3.6
September 5, 1908:									
5:35 p. m	16.2	99	se.	2.7	526	16.2	99	se.	2.7
5:49 p. m	16.1	100	se.	3.6	891	12.3	......	sse.	......
6:11 p. m	16.1	100	s.	4.5	1,040	11.2	......	se.	......
6:24 p. m	15.9	100	se.	4.9	1,116	12.3	......	s.	......
6:56 p. m	15.6	100	se.	4.9	1,727	10.5	......	s.	......
7:30 p. m	15.6	100	se.	6.7	1,162	12.3	......	s.	......
7:50 p. m	15.6	100	se.	6.3	526	15.6	100	se.	6.3
September 7, 1908:									
7:25 a. m	14.4	64	nw.	4.9	526	14.4	64	nw.	4.9
7:35 a. m	14.2	64	nw.	4.5	601	11.9	......	n.	......
7:46 a. m	14.4	68	nw.	4.0	1,096	10.8	......	n.	......
8:20 a. m	14.6	66	nw.	3.6	1,328	9.9	......	nw.	......
8:50 a. m	15.6	63	nw.	4.0	2,560	8.7	......	wnw.	......
10:01 a. m	16.7	57	nw.	4.5	3,316	5.7	......	wnw.	......
12:00 m	18.2	54	nw.	5.4	4,028	− 1.6	......	w	......
12:45 p. m	18.3	48	n.	4.5	3,161	4.9	......	wnw.	......
1:10 p. m	18.7	48	n.	4.5	2,457	7.4	......	wnw.	......
1:22 p. m	18.7	45	nw.	4.5	1,806	9.9	......	nw.	......
1:33 p. m	19.3	46	nw.	4.5	1,445	9.8	......	nw.	......
1:40 p. m	19.4	46	n.	4.5	894	14.4	......	nnw.	......
1:45 p. m	19.3	45	nw.	4.5	526	19.3	45	nw.	4.9
September 8, 1908:									
7:45 p. m	16.1	47	e.	4.9	526	16.1	47	e.	4.9
8:48 p. m	16.7	47	e.	4.0	985	13.0	......	e.	......
9:34 p. m	17.2	47	e.	4.0	1,461	8.2	......	ne.	......
9:47 p. m	17.4	45	e.	3.6	1,012	12.0	......	ene.	......
11:04 p. m	17.3	46	e.	2.7	526	17.3	46	e.	2.7

September 4, 1908.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 3,800 m.; at maximum altitude, 3,000 m.

From 2/10 to 7/10 Ci. moving from the west were visible during the flight.

High pressure prevailed along the Atlantic coast. A low was central over upper Lake Superior.

September 5, 1908.—Two kites were used; lifting surface, 14.6 sq. m. Wire out, 2,000 m., at maximum altitude.

Light rain and dense fog prevailed during the flight.

High pressure was central off the middle Atlantic coast. Low pressure was central north of Minnesota; and pressure was relatively low over the lower Mississippi Valley.

September 7, 1908.—Eight kites were used; lifting surface, 51.4 sq. m. Wire out, 7,000 m., at maximum altitude.

At the beginning 6/10 St.-Cu. moving from the west-northwest were observed. These decreased gradually until 11:05 a. m. when they entirely disappeared. From 1/10 to 4/10 Ci. from the west were present from 8:55 a. m. until the end of the flight.

Pressure was high over the Lake region and low over New Brunswick.

September 8, 1908.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 2,500 m.; at maximum altitude, 1,650 m.

The sky was cloudless during the flight.

High pressure prevailed over the lower Lakes. A low was central over Manitoba.

RESULTS OF CAPTIVE BALLOON ASCENSION.

Date and hour.	On Mount Weather, Va., 526 m. Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.	At different heights above sea. Height.	Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
September 9, 1908:									
10:02 a. m	20.0	53	s.	2.2	526	20.0	53	s.	2.2
10:17 a. m	19.9	52	s.	1.8	2,060	13.5	......	e.	....
10:45 a. m	20.8	45	s.	2.2	1,709	15.1	......	ese.	....
11:18 a. m	20.6	51	s.	2.6	1,447	15.5	......	se.	....
11:23 a. m	20.0	46	se.	2.7	1,016	14.5	......	s.	....
11:30 a. m	20.6	50	s.	2.7	770	16.6	......	s.	....
11:42 a. m	20.4	48	se.	3.1	526	20.4	48	se.	3.1
September 10, 1908:									
2:58 p. m	19.3	68	s.	1.8	526	19.3	68	s.	1.8
3:15 p. m	18.9	70	sw.	2.2	2,209	12.2	......	sse.	....
3:44 p. m	18.9	71	s.	2.2	1,437	18.7	......	s.	....
3:51 p. m	18.9	71	s.	2.2	974	20.0	......	s.	....
3:53 p. m	18.8	71	s.	2.2	848	17.0	......	s.	....
4:02 p. m	18.7	72	s.	2.2	526	18.7	72	s.	2.2

RESULTS OF KITE FLIGHTS.

September 11, 1908:									
7:09 a. m	16.8	74	nw.	4.0	526	16.8	74	nw.	4.0
9:18 a. m	18.9	61	nw.	4.5	774	20.5	......	nne.	....
9:37 a. m	19.4	62	nw.	4.0	1,404	17.3	......	ne.	....
10:10 a. m	20.8	62	nw.	2.7	2,238	10.4	......	n.	....
10:21 a. m	20.6	64	nw.	2.7	1,871	12.6	......	n.	....
10:41 a. m	21.6	57	nw.	1.3	1,358	17.5	......	nne.	....
10:55 a. m	22.4	51	nw.	2.2	526	22.4	51	nw.	2.2

September 9, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,350 m.

The sky was cloudless at the beginning of the ascension. After 11:23 a. m. a few Ci. were visible near the horizon.

High pressure was central over the Middle Atlantic States. A low was central over Lake Superior.

September 10, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,370 m.

At the beginning the sky was overcast with St.-Cu. moving from the southeast. During the ascension the amount decreased to 8/10 and the direction changed to south-southeast.

Pressure was high over West Virginia and low over Saskatchewan and the Gulf of St. Lawrence.

September 11, 1908.—Seven kites were used; lifting surface, 45.1 sq. m. Wire out, 3,250 m.; at maximum altitude the same.

From 1/10 to 4/10 Ci. moving from the north were visible during the flight.

A low was central over the lower St. Lawrence Valley. A high was central over southern Virginia.

RESULTS OF CAPTIVE BALLOON ASCENSION.

Date and hour.	On Mount Weather, Va., 526 m.: Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.	At different heights above sea. Height.	Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
September 12, 1908:									
11:08 a. m	24.1	51	w.	1.3	526	24.1	51	w.	1.3
11:20 a. m	25.9	54	se.	1.8	2,206	15.0	......	ne.	....
11:34 a. m	24.6	63	se.	1.8	1,573	20.2	......	ne.	....
12:02 p. m	25.3	58	se.	2.2	1,362	21.9	......	nne.	....
12:14 p. m	25.0	58	s.	2.2	946	22.1	......	ssw.	....
12:18 p. m	25.4	56	se.	1.8	526	25.4	56	se.	1.8

RESULTS OF KITE FLIGHTS.

September 14, 1908:									
11:19 a. m	22.1	57	ne.	5.4	526	22.1	57	ne.	5.4
11:29 a. m	22.2	61	ne.	5.4	833	20.0	......	ne.	....
11:50 a. m	22.2	61	ne.	4.5	1,248	17.0	......	ne.	....
12:20 p. m	22.2	57	ne.	4.0	1,541	15.5	......	ne.	....
12:48 p. m	22.5	56	ne.	3.6	1,825	13.5	......	ne.	....
1:26 p. m	23.1	52	e.	4.9	2,195	11.5	......	ne.	....
2:06 p. m	23.3	48	e.	4.0	2,693	7.3	......	ne.	....
2:50 p. m	23.6	51	e.	3.6	2,981	5.5	......	ne.	....
4:05 p. m	22.8	50	e.	4.9	3,460	1.9	......	ne.	....
4:49 p. m	22.2	50	e.	5.4	2,996	6.3	......	ne.	....
5:24 p. m	21.7	53	e.	4.9	2,440	7.6	......	ene.	....
5:40 p. m	21.1	52	e.	4.5	1,957	10.0	......	ene.	....
5:49 p. m	21.1	52	e.	4.5	1,556	13.5	......	ene.	....
6:00 p. m	21.1	52	e.	4.9	1,046	16.3	......	e.	....
6:17 p. m	20.8	52	e.	4.9	526	20.8	52	e.	4.9
September 15, 1908:									
8:38 a. m	13.9	75	se.	7.2	526	13.9	75	se.	7.2
8:49 a. m	14.3	74	se.	7.6	934	8.7	......	e.	....
9:04 a. m	14.4	68	se.	7.6	1,228	7.8	......	ene.	....
9:20 a. m	14.4	65	e.	8.0	1,682	7.4	......	ne.	....
9:32 a. m	14.4	62	se.	6.7	2,009	9.2	......	ne.	....
9:40 a. m	14.8	60	se.	6.3	2,824	10.2	......	ne.	....
10:21 a. m	15.3	63	e.	5.4	2,418	11.5	......	ne.	....
11:54 a. m	16.7	48	e.	5.4	2,780	9.2	......	ene.	....
12:33 p. m	16.8	49	e.	6.8	2,262	9.8	......	ene.	....
12:47 p. m	16.8	49	e.	7.6	1,756	9.6	......	ene.	....
1:21 p. m	17.2	47	e.	5.4	1,470	6.2	......	ene.	....
1:33 p. m	17.1	50	e.	6.3	1,001	11.2	......	ene.	....
1:58 p. m	17.2	51	e.	6.3	526	17.2	51	e.	6.3

September 12, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,390 m.

Light haze and cloudless sky prevailed during the ascension.

High pressure was central over West Virginia and north of the Great Lakes. Pressure was relatively low over South Dakota and off the south Atlantic coast.

September 14, 1908.—Eight kites were used; lifting surface, 51.4 sq. m. Wire out, 7,500 m.; at maximum altitude, 6,500 m.

Dense haze prevailed during the flight.

High pressure prevailed over the upper Lakes and low pressure off the Florida coast.

September 15, 1908.—Seven kites were used; lifting surface, 44.6 sq. m. Wire out, 6,600 m.; at maximum altitude, 4,050 m.

About 2/10 Ci. moving from the west, and a few Cu. moving from the east, were visible during the flight. A solar halo was seen from 11:15 to 11:30 a. m.

High pressure, central over northern Vermont, covered the eastern United States, except the Gulf coast. A tropical storm was east of the Florida coast.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.
September 16, 1908:	° *C.*	%		*Meters p. s.*	*Meters.*	° *C.*	%		*Meters p. s.*
9:36 a. m.	11.1	68	nw.	4.0	526	11.0	68	nw.	4.0
9:55 a. m.	11.7	70	nw.	4.0	833	9.0	......	nne.	....
10:19 a. m.	11.7	70	n.	4.0	1,195	6.5	......	ne.	....
10:34 a. m.	13.7	59	n.	4.5	1,576	10.0	......	ne.	....
12:07 p. m.	15.0	57	n.	4.0	1,945	10.0	......	nne.	....
12:27 p. m.	16.1	50	n.	3.6	2,424	9.0	......	nne.	....
12:39 p. m.	15.8	51	n.	3.6	1,970	9.0	......	nne.	....
12:48 p. m.	16.0	[illegible]	n.	4.0	1,408	7.6	......	nne.	....
12:54 p. m.	15.6	53	n.	3.1	526	15.6	......	n.	3.1
September 17, 1908:									
8:27 a. m.	11.6	64	nw.	6.3	526	11.6	64	nw.	6.3
8:37 a. m.	11.8	64	nw.	6.7	822	15.0	......	nnw.	....
9:02 a. m.	11.9	62	nw.	6.3	996	17.6	......	n.	....
10:33 a. m.	13.9	61	nw.	6.7	1,448	16.3	......	nne.	....
11:18 a. m.	14.4	60	nw.	7.2	2,171	12.4	......	nne.	....
11:30 a. m.	15.6	58	nw.	6.7	526	15.6	58	nw.	6.7
September 18, 1908:									
7:35 a. m.	14.6	56	nw.	5.4	526	14.6	56	nw.	5.4
7:50 a. m.	15.1	55	nw.	5.4	726	18.0	......	nw.	....
8:39 a. m.	15.8	52	nw.	5.4	1,235	19.9	......	nnw.	....
9:51 a. m.	17.2	53	nw.	6.8	1,884	17.1	......	nnw.	....
10:38 a. m.	18.4	48	nw.	6.7	1,851	13.0	......	nnw.	....
10:55 a. m.	18.9	43	nw.	6.7	1,206	17.3	......	nnw.	....
11:45 a. m.	20.0	47	nw.	5.8	1,054	19.0	......	nw.	....
12:06 p. m.	20.6	40	nw.	8.0	526	20.6	40	nw.	8.0
September 19, 1908:									
6:36 a. m.	20.0	34	w.	9.8	526	20.0	34	w.	9.8
6:45 a. m.	20.0	35	nw.	8.9	816	21.4	......	nw.	....
6:55 a. m.	20.1	35	nw.	8.9	1,071	20.6	......	nnw.	....
7:05 a. m.	20.1	35	nw.	8.9	1,302	19.7	......	n.	....
8:50 a. m.	20.5	40	nw.	8.9	1,618	18.2	......	n.	....
9:03 a. m.	20.7	39	nw.	8.9	1,285	20.9	......	nnw.	....
9:27 a. m.	21.8	39	nw.	8.9	877	21.9	......	nnw.	....
9:32 a. m.	21.7	38	nw.	9.4	526	21.7	38	nw.	9.4

September 16, 1908.—Six kites were used; lifting surface, 38.3 sq. m. Wire out, 3,300 m.; at maximum altitude, 3,200 m.

The sky was cloudless during the flight.

High pressure prevailed over the Middle and New England States. A low was central over Manitoba.

September 17, 1908.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 3,200 m., at maximum altitude.

The sky was overcast with Ci.-St. moving from the west. A brilliant solar halo was observed at 8:15 a. m., and continued thruout the flight.

High pressure was central over West Virginia, and a low pressure area of considerable energy was southeast of New England.

September 18, 1908.—Six kites were used; lifting surface, 38.3 sq. m. Wire out, 6,900 m.; at maximum altitude, 5,791 m.

The sky was obscured by dense haze until 10 a. m. From this time until the close of the flight 1/10 A.-St. was visible near the horizon.

A low was central over the Gulf of St. Lawrence and a high over Virginia and North Carolina.

September 19, 1908.—Six kites were used; lifting surface, 38.3 sq. m. Wire out, 6,400 m.; at maximum altitude, 4,200 m.

Light haze and a cloudless sky prevailed during the flight.

Pressure was high north of the Lakes and over the South Atlantic States, and was low east of New England and in southern Texas.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
September 21, 1908:	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
3:06 p. m.	18.8	85	se.	3.6	526	18.8	85	se.	3.6
5:05 p. m.	18.1	89	se.	3.6	746	16.2	......	se.	....
5:12 p. m.	17.8	90	se.	3.6	526	17.8	90	se.	3.6

RESULT OF CAPTIVE BALLOON ASCENSIONS.

September 22, 1908:									
1:01 p. m.	22.8	78	se.	2.2	526	22.8	78	se.	2.2
1:12 p. m	23.3	78	se.	1.8	1,875	21.4	....	e.	....
1:24 p. m.	22.8	78	se.	2.2	2,011	15.6	......	ene.	....
1:45 p. m.	23.4	75	se.	2.7	1,500	19.8	......	e.	....
1:56 p. m.	23.3	77	se.	2.7	1,418	20.6	......	e.	....
2:23 p. m.	23.3	74	se.	3.1	526	23.3	74	se.	3.1
September 23, 1908:									
1:28 p. m.	28.1	59	s.	1.8	526	28.1	59	s.	1.8
1:59 p. m.	27.8	49	sw.	2.7	2,371	14.0	......	o	....
2:18 p. m.	27.7	52	s.	2.2	2,072	17.9	......	o	....
2:42 p. m.	27.2	54	s.	1.3	1,486	22.1	......	wsw.	....
2:50 p. m.	27.7	55	s.	1.8	962	23.6	.....	wsw.	....
3:10 p. m.	27.2	54	sw.	2.2	778	24.4	......	w.	....
3:14 p. m.	27.2	54	s.	2.2	526	27.2	54	s.	2.2
September 24, 1908.									
2:31 p. m.	25.8	60	se.	1.8	526	25.8	60	se.	1.3
2:48 p. m.	25.8	64	se.	1.8	2,515	16.5	......	o	....
3:15 p. m.	25.3	64	se.	3.1	2,108	19.3	......	o	....
3:29 p. m.	25.3	64	se.	2.7	1,768	22.4	......	o	....
3:48 p. m.	25.1	66	se.	3.1	1,189	24.2	......	ne.	....
4:00 p. m.	25.0	69	se.	3.1	801	25.8	......	nne.	....
4:15 p. m.	24.8	65	se.	3.6	526	24.8	65	se.	3.6

September 21, 1908.—Three kites were used; lifting surface, 23.8 sq. m. Wire out, 1,650 m.; at maximum altitude, 600 m.

About 7/10 St. moving from the southeast and light haze were present during the flight.

Pressure was high over the middle Atlantic coast and low over North Dakota, with secondary depressions over the lower St. Lawrence and the Gulf of Mexico.

September 22, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,103 m.

Light haze prevailed during the ascension. About 1/10 St. moving from the east-northeast was visible after 1:14 p. m.

A high was central over West Virginia and a low over Manitoba.

September 23, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,150 m.

Light haze prevailed during the ascension.

A high was central over Virginia and North Carolina and a low over Lake Superior.

September 24, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,140 m.

Light haze prevailed thruout the ascension.

Pressure was high over West Virginia and north of Lake Huron and low over South Dakota and south of Florida.

RESULTS OF CAPTIVE BALLOON ASCENSION.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
September 25, 1908:	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
1:49 p. m	25.0	69	se.	1.3	526	25.0	69	se.	1.3
2:05 p. m	24.4	70	se.	1.8	2,298	15.3	......	ne.	....
2:30 p. m	24.2	64	se.	2.2	1,784	18.4	......	ne.	....
2:45 p. m	24.1	69	se.	2.7	1,524	20.5	......	ne.	....
2:51 p. m	23.9	69	se.	2.2	1,290	22.3	......	ne.	....
3:18 p. m	23.6	72	se.	2.2	526	23.6	72	se.	2.2

RESULTS OF KITE FLIGHTS.

Date and hour.	Air temperature.	Rel. hum.	Dir.	Velocity.	Height.	Air temperature.	Rel. hum.	Dir.	Velocity.
September 26, 1908:									
2:11 p. m	22.8	78	se.	4.5	526	22.8	78	se.	4.5
2:20 p. m	22.7	76	se.	4.5	774	20.8	......	se.	....
2:48 p. m	23.1	81	se.	3.1	1,182	21.7	......	ese.	....
3:14 p. m	22.7	78	se.	3.6	1,387	21.0	......	ese.	....
3:41 p. m	22.2	82	se.	3.6	1,726	17.8	......	ese.	....
4:20 p. m	21.7	86	se.	4.5	2,076	14.0	......	ese.	....
4:38 p. m	21.4	88	se.	4.5	2,356	11.5	......	ese.	....
5:00 p. m	20.9	88	se.	4.5	3,138	5.7	......	se.	....
5:22 p. m	20.6	90	se.	4.0	2,271	13.1	......	se.	....
5:34 p. m	20.1	91	se.	4.9	1,715	16.0	......	se.	....
6:02 p. m	19.4	95	se.	5.4	1,149	20.1	......	se.	....
6:16 p. m	19.2	95	se.	5.4	819	15.7	......	se.	....
6:23 p. m	19.0	96	e.	5.8	526	19.0	96	e.	5.8
September 28, 1908:									
2:30 p. m	21.7	90	s.	8.5	526	21.7	90	s.	8.5
2:45 p. m	21.8	90	sw.	8.5	949	18.2	......	ssw.	....
2:58 p. m	21.9	90	sw.	8.0	1,282	16.6	......	ssw.	....
3:03 p. m	21.8	90	s.	6.7	1,545	15.1	......	sw.	....
3:18 p. m	21.9	90	s.	6.7	1,803	13.2	......	sw.	....
3:35 p. m	22.7	87	s.	6.3	2,146	10.3	......	sw.	....
3:40 p. m	22.5	89	s.	6.3	2,385	12.6	......	sw.	....
4:08 p. m	22.5	89	se.	5.4	2,145	11.1	......	sw.	....
4:20 p. m	22.6	88	sw.	6.7	2,093	12.4	......	sw.	....
4:34 p. m	22.6	86	s.	5.8	1,729	13.6	......	sw.	....
4:46 p. m	22.5	84	se.	6.3	1,518	15.1	......	sw.	....
4:58 p. m	22.2	85	s.	6.3	1,281	15.7	......	ssw.	....
5:10 p. m	22.2	84	s.	6.7	948	18.4	......	ssw.	....
5:18 p. m	22.2	84	sw.	6.3	526	22.2	84	sw.	6.3

September 25, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,200 m.

Light haze prevailed during the ascension.

A high was central over New England and a low over Colorado.

September 26, 1908.—Six kites were used; lifting surface, 42.7 sq. m. Wire out, 4,700 m.; at maximum altitude, 3,870 m.

Light haze was present thruout the flight and light fog after 4:30 p. m. About 2/10 St. were visible until 2:30 p. m. Low St. appeared again at 4:15 p. m. and had practically covered the sky by 5 p. m. The clouds and fog were moving from the southeast. The head kite was hidden by clouds from 4:30 until about 6:14 p. m.

High pressure was central over the Middle Atlantic and lower New England States. An elongated low was central over northern Minnesota.

September 28, 1908.—Three kites were used; lifting surface, 13.2 sq. m. Wire out, 4,500 m., at the maximum altitude.

From 9/10 to 10/10 St.-Cu. moving from the south were present during the flight. A few A.-Cu. from the southwest could be seen occasionally thru rifts in the lower clouds. Rain began at 5:28 p. m. and the wind shifted to the northwest, attaining a maximum velocity of 57 miles at 9 p. m.

At 8 a. m. the pressure was high over eastern Montana and low over the upper Lake region.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
September 29, 1908:	° C.	%		Meters p. s.	Meters	° C.	%		Meters p. s.
9:10 a. m	7.1	63	nw.	11.2	526	7.1	63	nw.	11.2
9:15 a. m	7.2	65	nw.	10.7	781	3.1	......	nw.	......
9:30 a. m	7.7	58	nw.	9.8	1,242	4.1	......	nw.	......
10:00 a. m	9.3	56	nw.	10.7	1,819	1.6	......	wnw.	......
10:13 a. m	8.9	54	nw.	9.8	2,290	1.7	......	w.	......
10:32 a. m	9.1	51	nw.	7.6	2,553	0.2	......	wsw.	......
11:14 a. m	10.3	49	nw.	8.0	2,675	0.0	......	w.	......
11:30 a. m	11.1	47	nw.	8.0	2,981	− 1.4	......	wnw.	......
11:40 a. m	10.9	48	nw.	9.8	2,374	− 0.7	......	wnw.	......
12:01 p. m	11.8	46	nw.	10.3	1,556	2.8	......	wnw.	......
12:22 p. m	12.2	43	nw.	9.8	1,253	5.9	......	nw.	......
12:35 p. m	12.6	45	nw.	8.5	764	8.6	......	nw.	......
12:40 p. m	12.6	47	nw.	10.3	526	12.6	47	nw.	10.3
September 30, 1908:									
8:00 a. m	10.6	51	e.	4.0	526	10.6	51	e.	4.0
8:13 a. m	10.8	54	se.	4.5	724	9.1	......	ese.	......
8:39 a. m	10.6	55	se.	4.5	913	9.1	......	se.	......
9:00 a. m	10.7	57	se.	4.5	1,257	5.9	......	sse.	......
9:24 a. m	10.7	62	se.	4.9	1,404	3.7	......	ssw.	......
11:20 a. m	13.7	53	se.	4.9	2,684	3.3	......	wsw.	......
12:01 p. m	14.2	50	se.	4.9	3,239	1.4	......	wsw.	......
12:36 p. m	15.0	44	se.	5.4	4,045	− 3.4	......	wsw.	......
12:56 p. m	15.0	46	se.	5.4	4,608	− 6.9	......	wsw.	......
1:13 p. m	15.2	47	s.	4.9	5,184	−11.4	......	wsw.	......
1:33 p. m	15.5	45	s.	4.9	5,783	−13.4	......	wsw.	......
2:06 p. m	15.2	48	s.	4.9	6,344	−18.9	......	wsw.	......
3:10 p. m	16.1	50	s.	4.5	6,749	−24.6	......	wsw.	......
3:56 p. m	15.6	49	s.	4.5	526	15.6	49	s.	4.5

September 29, 1908.—Five kites were used; lifting surface, 22.8 sq. m. Wire out, 5,700 m.; at maximum altitude, 4,500 m.

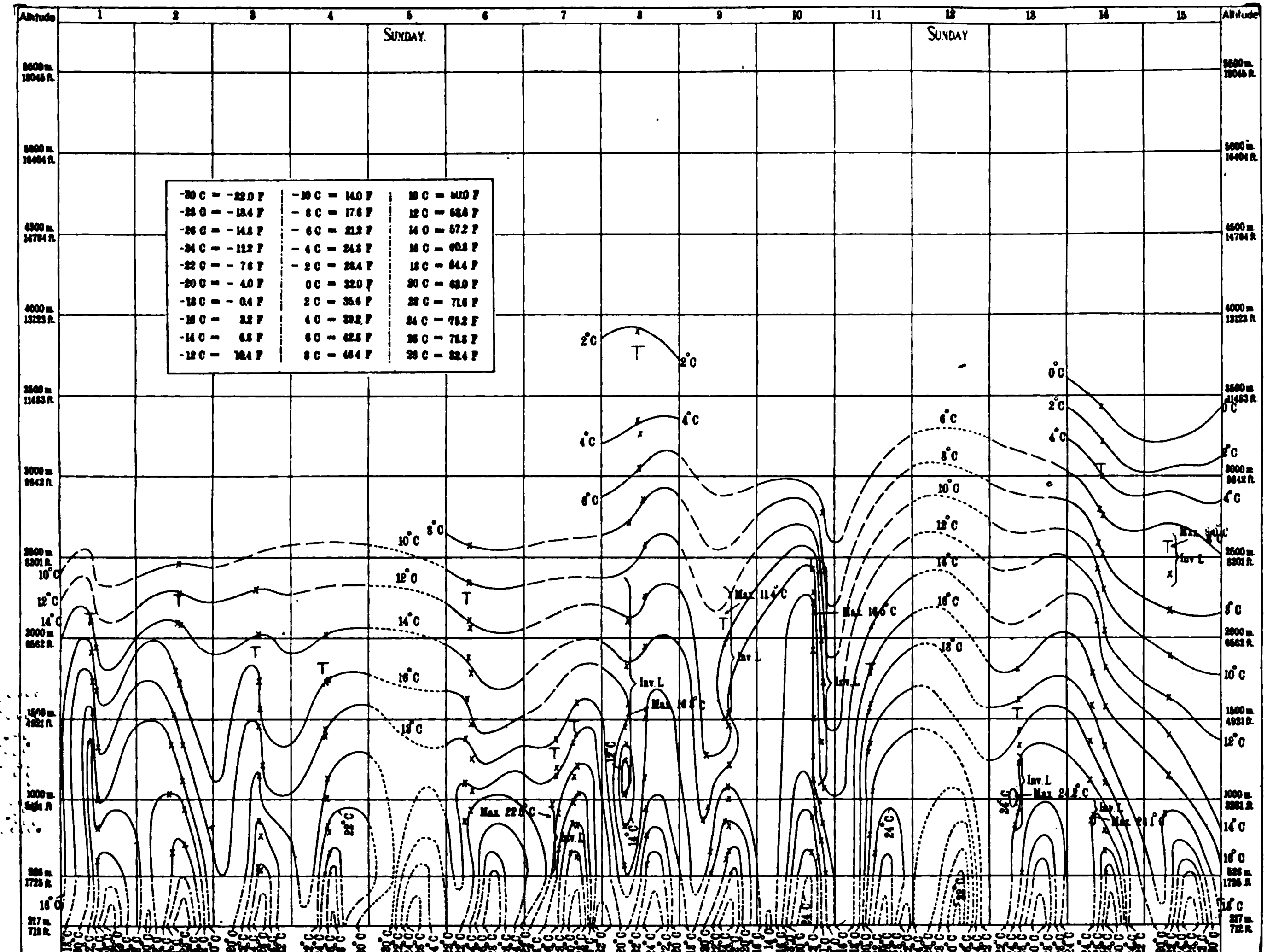
The sky was cloudless until 12:20 p. m. A few St. moving from the west were visible thereafter.

A high was central over Missouri and Arkansas and a low over eastern Cuba.

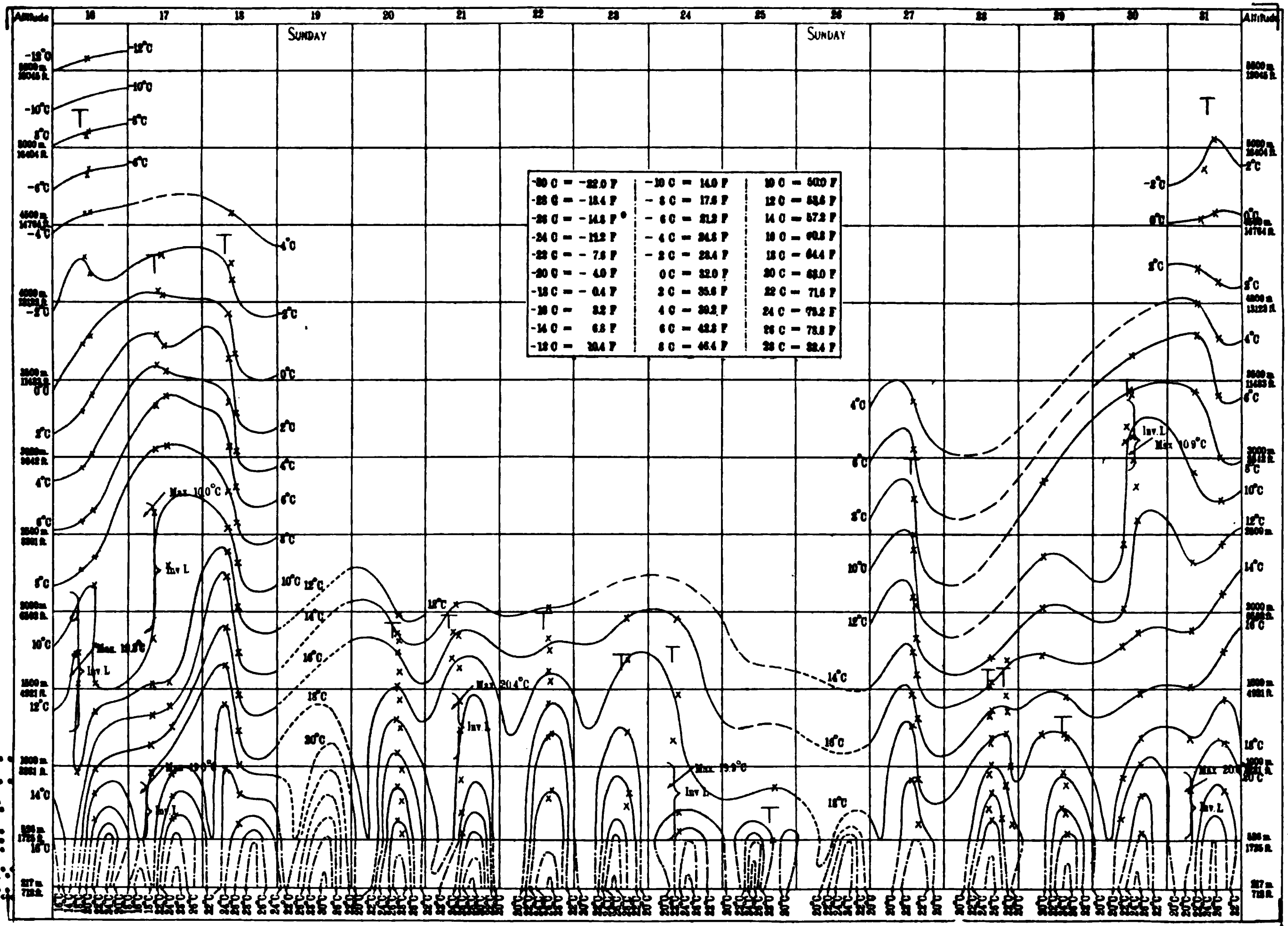
September 30, 1908.—Nine kites were used; lifting surface, 57.2 sq. m. Wire out, 14,200 m; at maximum altitude, 13,800 m.

About 1/10 Ci. moving from the west was present until 4:30 p. m., and a few Cu. moving from the southeast were visible from 11 a. m. until 2 p. m.

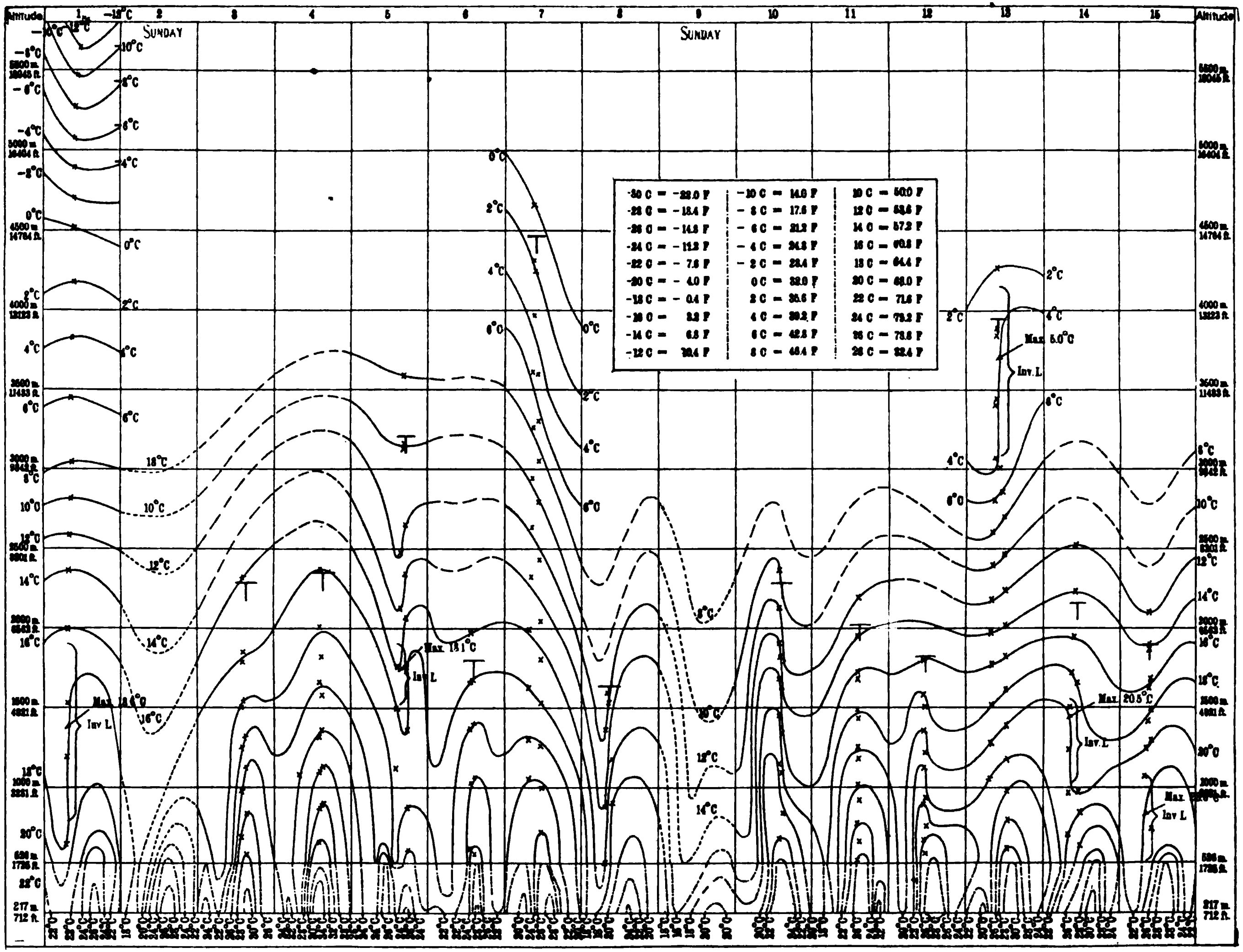
A storm of considerable intensity was central over Wisconsin. Centers of high pressure lay over West Virginia and Massachusetts.



Upper air isotherms, July 1-15, 1908.

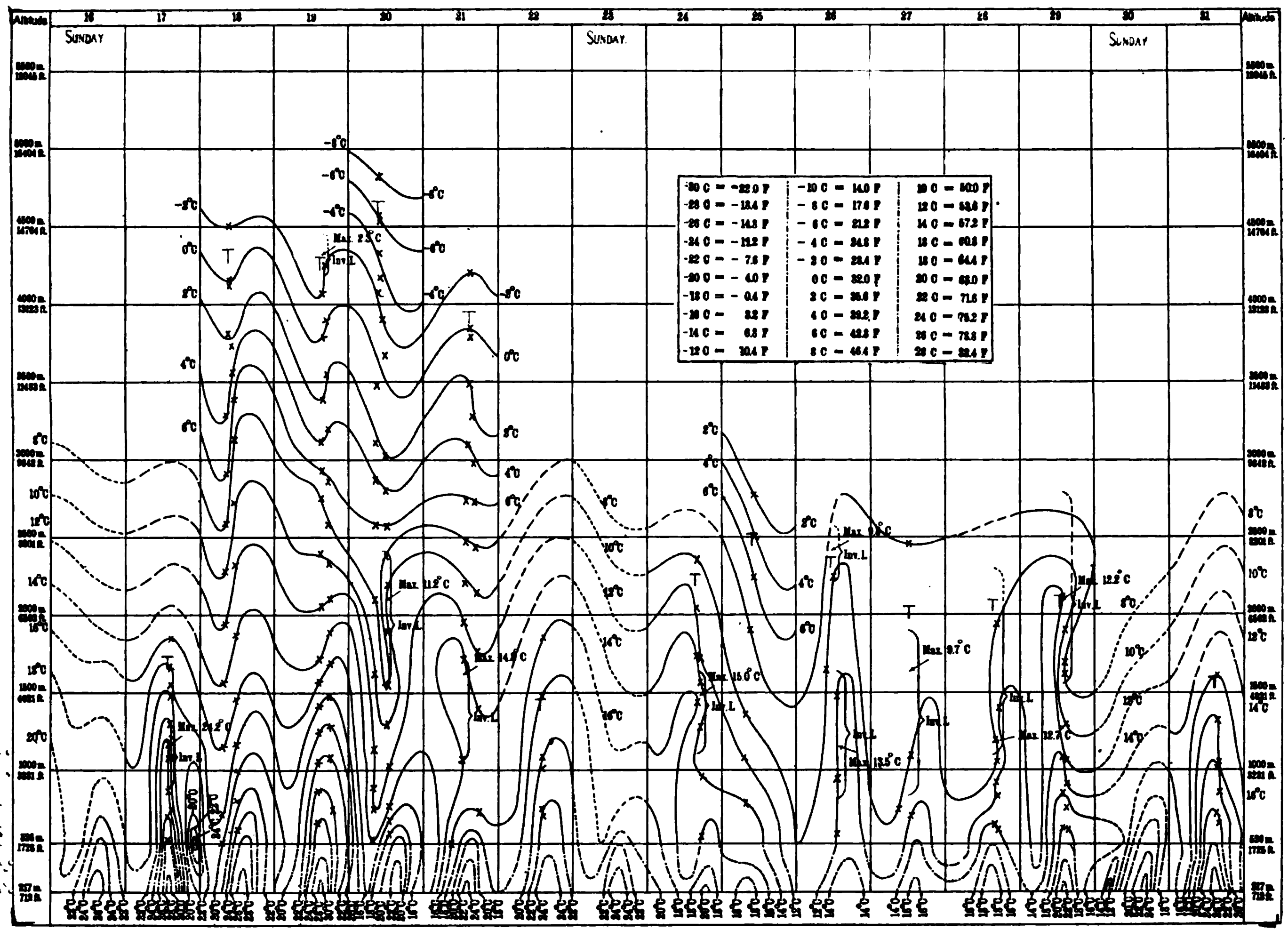


Upper air isotherms, July 16–31, 1908.

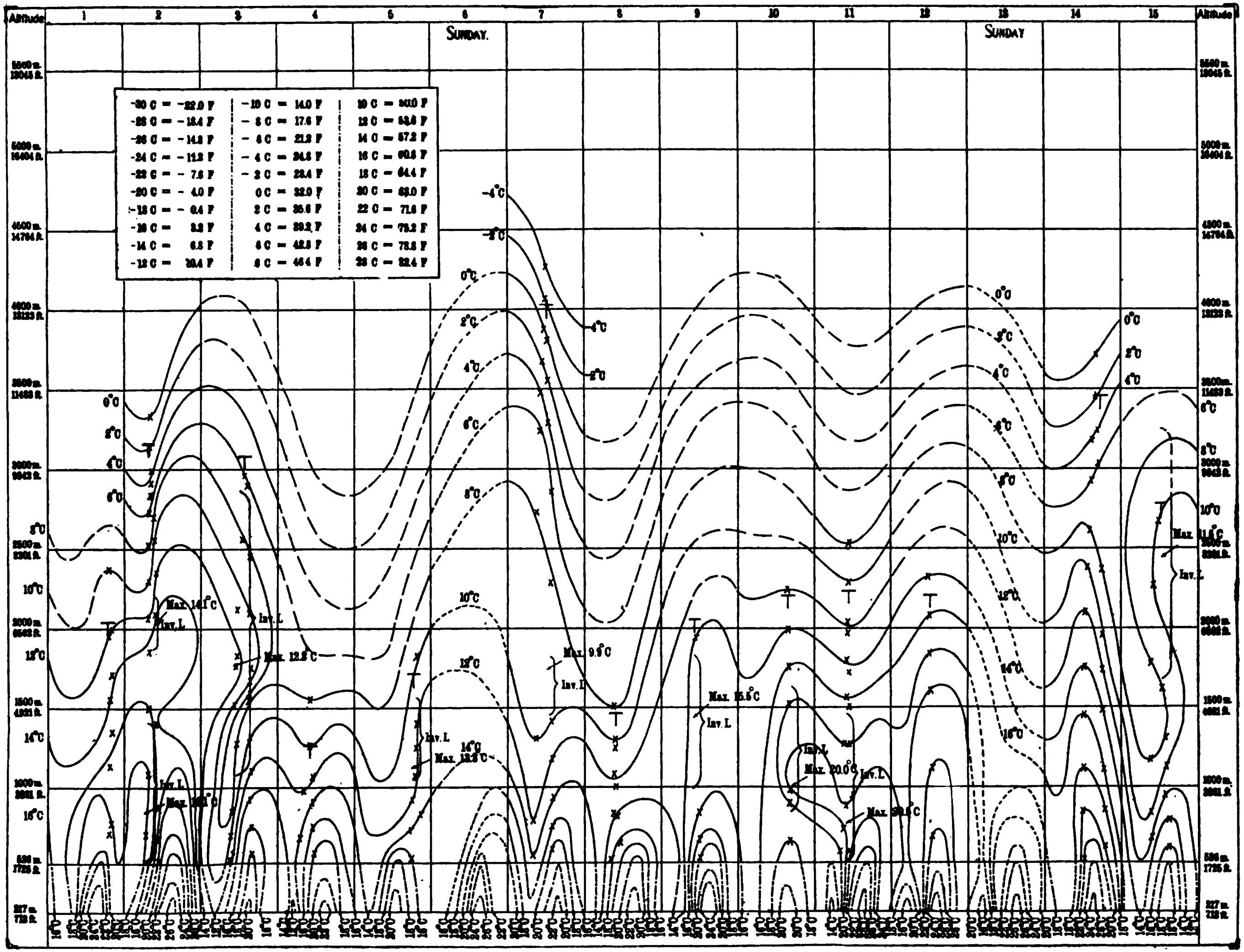


Upper air isotherms, August 1-15, 1908.

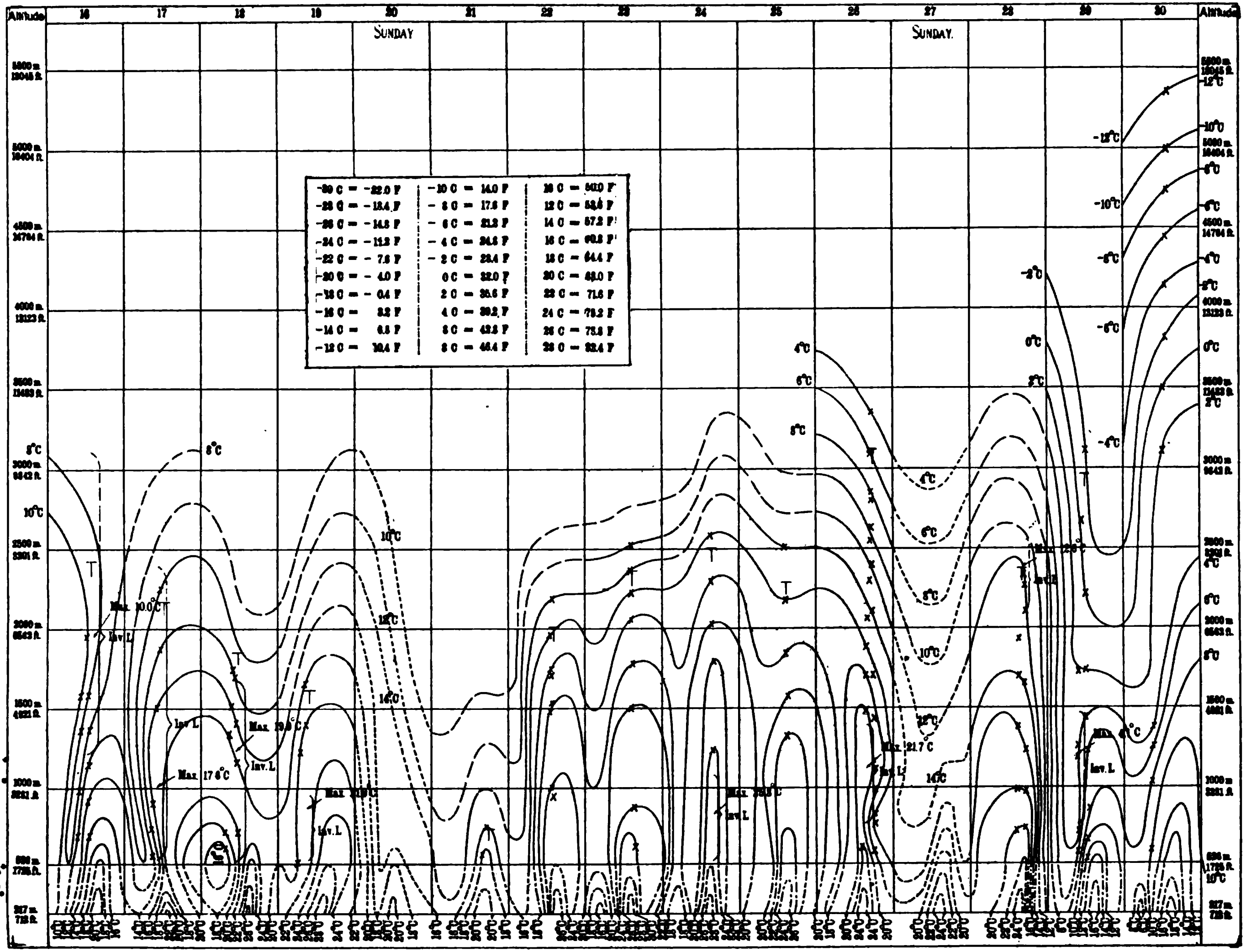
Chart IV.



Upper air isotherms, August 16–31, 1908.



Upper air isotherms, September 1–15, 1908.



Upper air isotherms, September 16–30, 1908.

W. B. No. 412. Issued July 15, 1909.

U. S. DEPARTMENT OF AGRICULTURE

Vol. II **BULLETIN** Part 2

OF THE

MOUNT WEATHER OBSERVATORY

PREPARED UNDER THE DIRECTION OF

WILLIS L. MOORE, D. Sc., LL. D.
CHIEF U. S. WEATHER BUREAU

WASHINGTON
U. S. WEATHER BUREAU
1909

CONTENTS.

CHARTS.

ERRATA.

Substitute the following for all after the word "beam," in the sixth line of text from the bottom of page 55, to the end of the first paragraph on page 56:

"and parallel to the plane of vibration of the ray scattered. Suppose the vibrations in a ray propagated in the direction of *IO* to be parallel to *OP*; the scattering will be symmetrical about *OP* as an axis, being zero in the direction *OP*, and reaching a maximum 90° from it. Similarly any other ray propagated in the direction *IO* will be scattered symmetrically about an axis perpendicular to *IO* and parallel to its path of vibration. The vibrations of any one of these scattered rays will be in a plane containing the corresponding axis of symmetry and the ray itself. But since in a beam of unpolarized light the vibrations occur in all planes that pass thru the direction of propagation, there will in this case result a symmetrical scattering about *IO* as an axis, with complete polarization in the plane *APB*, diminishing to zero polarization 90° from this plane."

PYRHELIOMETER AND POLARIMETER OBSERVATIONS.

By H. H. Kimball.

The Relation between Sky Polarization and the General Atmospheric Absorption.

General Remarks.

In previous papers[1], reference has been made to an apparent relation between the percentage of polarization of skylight, and the transmissibility of the atmosphere for solar radiation. Numerous writers have referred to the relation between the percentage of polarization of skylight and weather conditions, among the more recent being Dorsey[2], Schultz[3], Bell[4], and Nichols[5]. Dorsey in his paper also gives a summary of the various theories that have been advanced to account for the polarization of skylight, including the classical treatment of the subject by Rayleigh.

In fig. 1, let IO be the direction of propagation of a beam of light thru the atmosphere, I being in front of the plane of projection, and APB a plane at right angles to IO. Rayleigh demonstrated mathematically that a beam of light in passing thru a medium made turbid by the presence of particles whose diameters are small as compared with the wave length of light will be scattered laterally and polarized, the intensity of the scattered polarized light being symmetrical about an axis perpendicular to the direction of propagation of the beam, and also perpendicular to the plane of vibration of the ray scattered. Suppose the vibrations in a ray propagated in the direction of IO to be in a plane at right angles to OP; then the polarization will be symmetrical about OP as an axis, and will be complete in the direction of OP, but will become zero 90° from this direction.

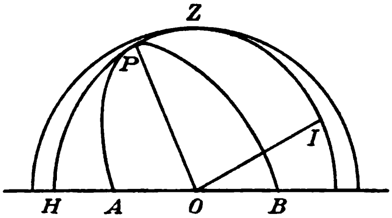
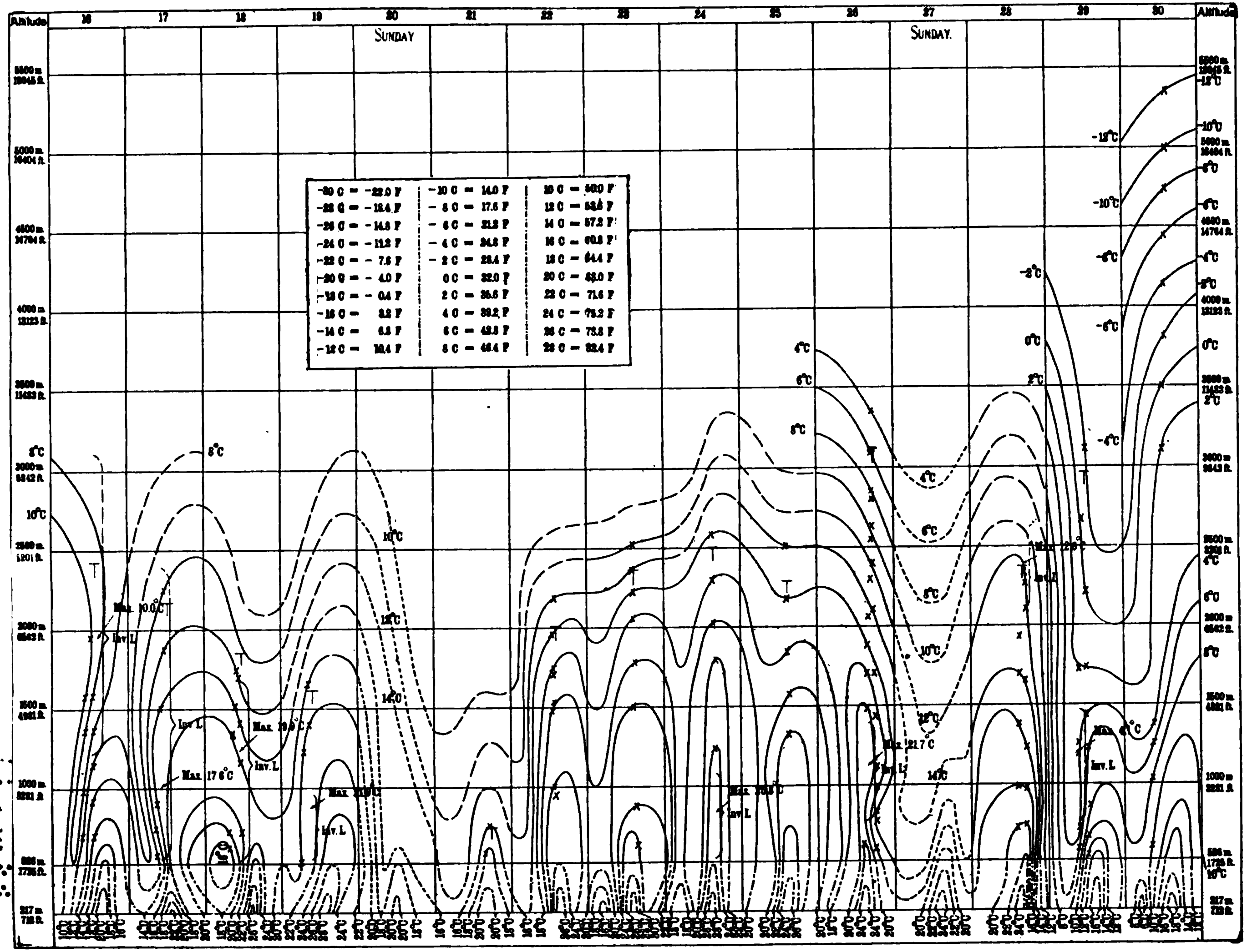


Fig. 1.—Plane of maximum polarization.

[1] Monthly Weather Review, July, 1903, Vol. 31, p. 332. Proceedings of the Third Convention of Weather Bureau Officials, Peoria, Ill., September, 1904, p. 71.
[2] Monthly Weather Review, September, 1900, Vol. XXVIII, p. 382.
[3] Proceedings of the Second Convention of Weather Bureau Officials, Milwaukee, Wis., August, 1901, p. 28.
[4] Proc. of the Amer. Acad. of Arts and Sciences, March, 1908, Vol. XLIII, p. 407.
[5] Physical Review, June, 1908, Vol. XXVI, p. 497.

Chart VI.



Upper air isotherms, September 16–30, 1908.

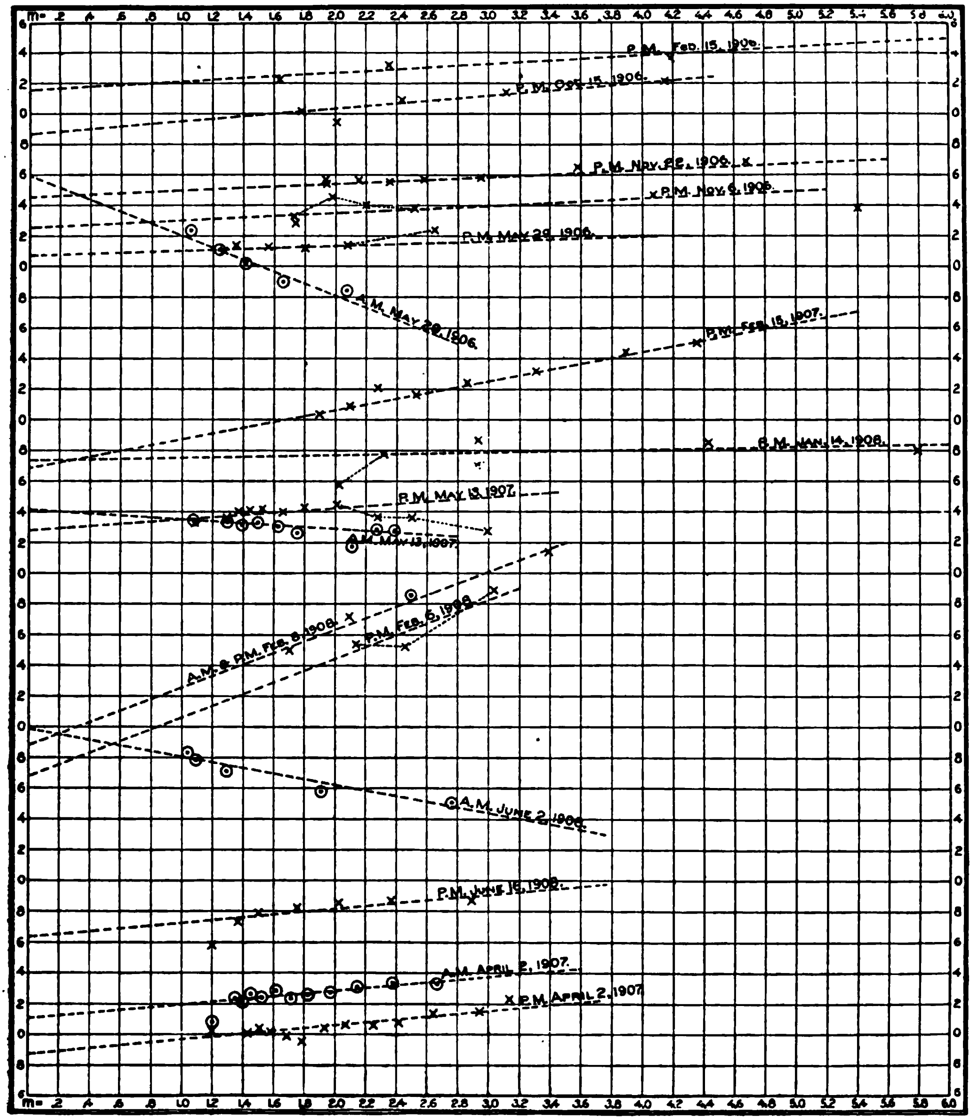


FIG. 2.—Polarization observations.

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creases, but quite irregularly, owing principally, no doubt, to the erroneous assumption made in computing δ, that the atmospheric transmissibility does not change during the time required to make the series of pyrheliometric readings employed in the computation. While this assumption is approximately true on some days, on others it is far from the truth.

The value of R_0 in equation (3) must vary with the albedo, or the reflecting power, of the earth's surface, and it has been found that there is a marked diminution of polarization, and a marked increase in the value of a_x, when the ground is covered with snow. The observations of January 9 and 10, and March 22, 1905, January 28 and February 12, 15, and 25, 1907, and February 6 and 8, 1908, have therefore been omitted from Table 2, as there was snow on the ground in the vicinity of Washington on those dates.

In computing the relation between P_2 and δ their corresponding values were arranged in four groups, and the means of each group obtained as indicated in Table 2. The means of the third group, $P_2=62.2$ and $\delta=0.618$, were given double weight, and by the least squares method the equation

$$\delta'=0.1717-0.03929\,(100-P_2)+0.000975\,(100-P_2)^2 \ldots\ldots (4)$$

was obtained. It seemed logical to find the relation between δ and the unpolarized component of skylight, $(100-P_2)$. The values of δ' given in column 5 of Table 2 have been computed from equation (4).

In column 6, of Table 2, Q_0 is the value of the radiation outside the atmosphere computed from δ, the vapor pressure, and the intensity of solar radiation thru air mass 2; δ having first been obtained from the ratio of pyrheliometer readings thru air mass 3 and air mass 2, respectively, in connection with the vapor pressure. This method of computing the solar constant is fully developed in Reduction of pyrheliometric observations.

In column 7, Q'_0 is the value of the radiation outside the atmosphere computed from δ', the vapor pressure, and the intensity of solar radiation thru air mass 2; δ' having been obtained from the value of P_2 by means of equation (4).

The difference in the methods of computing Q_0 and Q'_0 consists solely in the methods of obtaining δ and δ', δ depending upon a ratio between pyrheliometric readings that it may require two hours to obtain, and a value of the vapor pressure that may have varied during this interval, while δ' is obtained from a measurement of the percentage of polarization of skylight that is made practically simultaneously with the determination of the vapor pressure, and of the intensity of the solar radiation thru air mass 2.

TABLE 2.—*Relation between polarization and general absorption.*

Date.	P_2	a_x	δ	δ'	Q_o	Q'_0	Rel. wt.	Remarks.
Nov. 1, 1906, p. m.	71.6	1.007	0.580	0.391	2.131	2.023	5	
Nov. 22, 1906, p. m.	71.5	1.009	0.265	0.392	1.942	2.051	6	
Nov. 2, 1906, a. m.	71.0	1.014	0.355	0.400	1.966	2.006	4	
Nov. 3, 1906, p. m.	71.0	1.006	0.440	0.400	2.076	2.043	8	
Nov. 7, 1906, a. m.	70.6	1.023	0.270	0.407	1.942	2.029	1	
Nov. 3, 1906, a. m.	70.3	1.030	0.290	0.418	1.966	2.054	4	
Nov. 2, 1906, p. m.	70.1	1.011	0.420	0.417	1.991	1.988	8	
Weighted means.	70.9	1.012	0.388	0.408	2.014	2.026	......	
Jan. 21, 1907, p. m.	69.2	1.012	0.455	0.435	2.004	1.990	5	
Feb. 18, 1907, a. m.	68.9	1.060	0.480	0.441	2.129	2.101	1	
Jan. 29, 1906, p. m.	68.6	0.993	0.785	0.447	2.153	1.953	3	Smoke depressed values of Q_m.
Dec. 26, 1905, p. m.	68.4	1.008	0.540	0.452	1.960	1.919	5	
Nov. 6, 1906, p. m.	68.4	1.012	0.545	0.452	2.118	2.020	8	
Jan. 23, 1907, p. m.	67.8	1.016	0.580	0.466	2.101	2.057	4	
Nov. 7, 1906, p. m.	67.6	1.009	0.550	0.471	2.075	2.016	6	
Apr. 2, 1907, a. m.	67.4	1.021	0.410	0.475	2.039	2.078	8	
Feb. 15, 1906, p. m.	67.2	1.018	0.510	0.480	2.075	2.058	6	
Nov. 27, 1906, p. m.	67.1	0.991	0.750	0.482	2.145	1.958	2	Smoke depressed values of Q_m.
Dec. 22, 1905, p. m.	67.0	1.018	0.514	0.484	1.979	1.958	4	
Mar. 20, 1907, p. m.	66.8	1.014	0.450	0.499	1.953	1.988	3	
Nov. 6, 1906, a. m.	66.4	1.009	0.620	0.501	2.129	2.040	5	
Apr. 2, 1906, p. m.	66.1	1.005	0.660	0.508	2.071	1.963	6	
Feb. 13, 1906, p. m.	65.9	1.034	0.400	0.514	1.953	2.086	6	
Mar. 25, 1907, p. m.	65.2	1.021	0.440	0.534	1.970	2.040	2	
May 29, 1906, p. m.	65.1	1.008	0.440	0.537	2.000	2.074	7	
Mar. 2, 1907, p. m.	64.5	1.040	0.255	0.553	1.920	2.037	2	
Weighted means.	67.1	1.014	0.513	0.484	2.043	2.018		
Apr. 2, 1907, p. m.	63.8	1.021	0.620	0.575	2.083	2.011	4	
Dec. 31, 1907, p. m.	63.8	....	0.485	0.575	2.000	2.064	4	
Oct. 15, 1906, p. m.	63.6	1.020	0.555	0.582	2.006	2.022	4	
Oct. 9, 1907, a. m.	63.4	....	0.480	0.588	1.945	2.019	2	
Oct. 9, 1907, p. m.	62.5	0.988	0.965	0.618	2.043	1.880	1	Values of Q_m unreliable.
Oct. 8, 1907, p. m.	62.4	1.012	0.460	0.622	1.997	2.113	3	
Jan. 30, 1908, a. m.	62.0	1.000	0.535	0.635	1.994	2.062	8	
Jan. 30, 1908, p. m.	62.0	....	0.460	0.635	1.988	2.111	7	
June 16, 1908, p. m.	61.1	1.021	0.450	0.667	1.948	2.113	2	
May 29, 1906, a. m.	61.0	0.889	0.750	0.671	2.104	2.052	9	Atmosphere clearing.
Apr. 11, 1908, p. m.	60.9	1.013	0.740	0.675	2.179	2.134	1	
Mar. 15, 1907, p. m.	60.8	1.009	0.710	0.679	2.008	1.986	2	
Weighted means.	62.2	1.005	0.618	0.632	2.023	2.060	......	
Apr. 16, 1908, p. m.	57.8	....	0.775	0.799	2.031	2.046	4	
June 2, 1908, a. m.	57.8	0.959	0.650	0.799	2.028	2.184	3	Abnormal polarization.
Jan. 14, 1908, p. m.	57.2	1.008	0.590	0.825	2.018	2.053	3	
Apr. 21, 1908, p. m.	57.1	0.984	1.870	0.829	2.885	2.010	5	Haze increasing.
May 13, 1907, p. m.	55.3	1.014	1.000	0.918	2.035	1.980	10	
Oct. 15, 1907, p. m.	54.8	0.994	1.110	0.937	1.922	1.882	4	Maximum P and Q for $m=2$.
Apr. 18, 1906, a. m.	53.9	1.009	1.315	0.982	2.100	1.911	5	Short record. Unreliable.
May 13, 1907, a. m.	53.6	0.993	0.965	0.997	1.991	2.009	10	
Oct. 10, 1907, p. m.	52.9	0.975	0.945	1.033	1.900	1.953	3	Depression in Q for $m=2.5$.
July 27, 1907, a. m.	52.6	0.917	0.660	1.050	1.987	2.251	3	Abnormal polarization.
June 8, 1908, p. m.	52.2	0.998	0.785	1.071	1.988	2.117	1	
May 1, 1908, a. m.	52.1	....	1.160	1.076	2.170	2.116	1	
June 27, 1908, a. m.	52.0	....	0.955	1.081	1.992	2.076	2	
Apr. 29, 1908, p. m.	51.9	0.942	1.250	1.087	2.115	2.022	3	Haze increasing.
Apr. 17, 1906, a. m.	51.6	1.038	1.080	1.105	1.989	2.004	9	
Apr. 17, 1908, a. m.	51.4	....	0.930	1.115	1.812	1.912	2	Values of P unreliable.
Jan. 9, 1908, p. m.	51.4	1.021	0.585	1.115	1.547	2.198	2	Marked fluctuations in P and Q_m.
Apr. 17, 1906, p. m.	51.0	1.037	1.150	1.137	1.994	1.983	9	
Apr. 25, 1907, a. m.	48.4	1.030	1.175	1.622	1.881	2.126	2	
May 18, 1906, p. m.	42.5	1.041	1.395	1.686	1.838	1.986	3	
Weighted means.	53.1	1.003	1.027	1.032	2.011	2.014		

We should therefore expect the values of Q'_0 to show less variations than the values of Q_0; and this is the case if we exclude certain days on which the conditions were so bad that the readings of the

polarimeter or the pyrheliometer, or both, for air mass 2, were quite uncertain. We must also take into account the fact that with a hazy or a smoky atmosphere the conditions in the direction of the sun may differ from the conditions 90° from the sun. Especially is this true at the Weather Bureau in Washington, which has to the south of it the gas works, the electric light and power plants, and other manufacturing concerns, which at times send clouds of smoke into the atmosphere, while to the north is a residence section comparatively free from smoke. It is not surprising, therefore, that on certain dates, as January 29, 1906, December 26, 1905, November 27, 1906, and December 22, 1905, the pyrheliometric readings should appear to be too low for the corresponding polarimeter readings.

Reference to fig. 2, in Reduction of pyrheliometric observations, shows that the atmospheric transmissibility was increasing thruout the day on May 29, 1906, and that it was a little greater during the afternoon of May 13, 1907, than during the morning of the same day. The low value of a_x, on the mornings of these two days may therefore be attributed to increasing atmospheric transmissibility. Similarly, while there are no morning pyrheliometric observations on April 21 and 29, 1908, with which to compare the afternoon observations, the evidence is quite conclusive that the low values of a_x, obtained on the afternoons of these two dates, are to be attributed to decreasing atmospheric transmissibility during the periods of observation.

On the afternoons of October 9, 10, and 15, 1907, and January 9, 1908, and the morning of April 17, 1908, conditions were too unsteady to obtain reliable readings with either the pyrheliometer or the polarimeter; while on account of the short record on the morning of April 18, 1906, there is considerable uncertainty with respect to the extrapolated values for $m=2$.

On the mornings of June 2, 1908, and July 27, 1907, the polarization during the early morning was much too low for the pyrheliometer observations obtained at the same time, as compared with the results obtained on other days. The explanation is not at present apparent.

An examination of Table 2 shows that generally a high value of a_x accompanies a low value of Q_0, as it should, since it signifies relatively low atmospheric transmissibility with the sun near the meridian.

If we exclude from our results the data for all the dates which, as indicated above, appear to be questionable, we have left for the extreme values of Q_0, 2.179 on April 11, 1908, and 1.838 on May 18, 1906;

while the extreme values for Q'_0 are 2.134 on April 11, 1908, and 1.963 on April 2, 1906. In column 9 of Table 1 the values of Q'_0 for all dates not excluded as above are arranged chronologically. Evidently there are not enough observations to detect variations in the solar constant of the order of magnitude that are indicated by Abbot's[13] observations on Mount Wilson. Especial attention is invited to the slight variations during October and November, 1906, amounting to only 3 per cent for eleven determinations, which is no greater than the possible error due to the combined effects of inaccurate determination of the vapor content of the atmosphere and inaccuracies in the pyrheliometer readings.

SUMMARY.

The results obtained above may be summarized as follows:

1. Since the observations were made on cloudless days, the sources of illumination of the sky are considered to be (*a*) the scattering of light by particles in the atmosphere whose diameters are small as compared with the wave-length of light, (*b*) the scattering of light by relatively large particles, and (*c*) the reflection of light from the surface of the earth. At the point of maximum polarization the component depending upon (*a*) is polarized, while the components depending upon (*b*) and (*c*) are, in effect, unpolarized.

2. When the ground is covered with snow there is a marked decrease in the percentage of polarization, due to increased reflection from the surface of the earth.

3. There is a diurnal variation in the percentage of polarization, the minimum polarization occurring at noon, with a gradual increase as the sun approaches the horizon, and a marked increase during the first few minutes of twilight following sunset, which may be attributed to relatively less reflection from the ground than from the particles in the atmosphere as the zenith distance of the sun increases.

4. The percentage of polarization decreases as the general atmospheric absorption increases, but apparently not by a simple law. Determinations of the general atmospheric absorption based on polarization observations alone appear in general, however, to be at least equally as reliable as determinations based on pyrheliometric and psychrometric observations. Polarization observations are, therefore, a useful and independent check upon results obtained from pyrheliometer readings.

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[13] Annals of the astrophysical observatory of the Smithsonian Institution, Vol. 2, p. 96–97.

DISTRIBUTION OF GASES IN THE ATMOSPHERE.

By W. J. Humphreys.

The distribution of the atmospheric gases has several times been calculated[1] according to one or another assumption as to the vertical temperature gradient, as to the relative proportions of the several gases in dry atmosphere, and even as to what gases are actually present.

The subject is of general interest and also, in some particulars, of distinct importance to meteorology. And for these reasons it seemed worth while to recalculate this distribution, since the most recent determinations of the factors upon which it depends differ materially from those formerly assumed.

Therefore the accompanying table, calculated according to Ferrel's formula for latitude 45°, and graphically represented in fig. 1, is based on the following assumptions which correspond, we believe, to approximately average conditions:

1. That the several gases, in addition to water vapor, present to an appreciable extent in the atmosphere, and their volume percentages in day air at the surface of the earth, are, as Hann[2] gives them:

Nitrogen	78.03	Hydrogen	0.01
Oxygen	20.99	Neon	0.0015
Argon	0.94	Helium	0.00015
Carbon dioxide	0.03		

2. That water vapor is present to the extent of 1.2 per cent of the total gases at the surface of the earth, and that it decreases rapidly with increase of elevation, to an imperceptible amount at or below the level of 10 kilometers.

3. That the surface temperature is 11° C.

4. That the temperature decreases uniformly, at the rate of 6° C. per kilometer, from the surface to an elevation of 11 kilometers, where it is −55° C.

5. That beyond 11 kilometers above sea level the temperature remains constant at −55° C.

[1] Ferrel, Recent Advances in Meteorology, p. 37, 1886.
Dewar, Proceedings Royal Institution, London, 17, p. 223, 1902.
Hann, Lehrbuch der Meteorologie, p. 8, 1906.

[2] Lehrbuch der Meteorology, p. 5.

FIG. 1.

6. That convection, and therefore constant volume percentage of the gases, except as slightly modified by the presence of water vapor obtains thruout the region of temperature changes; that is, from the surface up to the region of constant temperature.

7. That in the region of constant temperature, or that above 11

kilometers elevation, there is no convection, and that therefore in this region the several gases present can and do distribute themselves according to their respective molecular weights.

One of the above-mentioned gases, neon, constitutes only about the one-seven-hundredth part of one per cent of the lower atmosphere, and a rapidly decreasing proportion of the upper atmosphere. Therefore, like crypton, zenon, and some others, it is too small in amount to appear on the graphical representation.

The ozone, if present in the upper atmosphere, as there is reason to believe it is, probably forms and decomposes over and over again, so that presumably the oxygen settles to rather lower levels and disappears correspondingly earlier than shown by the diagram, fig. 1, and the table.

Percentage distribution of gases in the atmosphere.

Height in kilometers.	Gases.							Total pressure in millimeters.
	Argon.	Nitrogen.	Water vapor.	Oxygen.	Carbon dioxide.	Hydrogen.	Helium.	
150	....	....	....	....	....	99.73	0.27	.0043
140	....	....	....	....	....	99.70	0.30	.0048
130	....	0.02	....	....	....	99.64	0.34	.0054
120	....	0.10	....	....	....	99.52	0.38	.0060
110	....	0.40	....	0.02	....	99.16	0.42	.0067
100	....	1.63	....	0.07	....	97.84	0.46	.0076
90	....	6.57	....	0.32	....	92.62	0.49	.0090
80	....	22.70	....	1.38	....	75.47	0.45	.0123
70	0.02	53.73	....	4.05	....	41.95	0.27	.0248
60	0.04	78.16	....	7.32	....	14.33	0.15	.0810
50	0.08	86.16	....	10.01	....	3.72	0.08	.466
40	0.16	86.51	....	12.45	....	0.88	....	1.65
30	0.22	84.48	....	15.10	....	0.20	....	8.04
20	0.55	81.34	....	18.05	0.01	0.05	....	39.6
15	0.74	79.56	....	19.66	0.02	0.02	....	88.2
11	0.94	78.02	0.01	20.99	0.03	0.01	....	168
5	0.94	77.89	0.18	20.95	0.03	0.01	....	405
0	0.93	77.08	1.20	20.75	0.03	0.01	....	760

The distribution of the gases of the upper atmosphere may, in some respects, be distinctly different from that indicated. We know the conditions, and they are as here represented, tolerably accurately below the isothermal region; and we also know something of the conditions of even this region up to about 30 kilometers. We know that in it the winds are much less than they are in the upper portions of the convective region, that they are excessively dry, and that up to 15 kilometers at least, the composition of the air is sensibly that of dry atmosphere at lower levels. As to the conditions above 30 kilometers we have only such evidence as has been gathered from meteors, from auroras, and from volcanic dust; evidence that gives some knowledge of the direction and speed of the winds in these high alti-

tudes, and that indicates the presence of an appreciable percentage of hydrogen and of helium in the outer atmosphere.

The table and fig. 1 must, therefore, be understood to represent both what we know of the lower atmosphere, and what we have reason to believe true of the upper. The one part shows what we are certain of, the other indicates what to look for.

Probably that fact in regard to the gases of the atmosphere most surprising to the average person, is, when its immense importance is considered, the relatively small amount of water vapor. An amount which even at the surface of the earth often is no greater than that of argon, and for the total atmosphere scarcely one-fourth as great.

NOTE ON THE TEMPERATURE OF THE ISOTHERMAL REGION.

By W. J. Humphreys.

On pages 12 and 13, Vol. II, of this Bulletin is calculated the effect of the planetary radiation of the earth on the temperature of the outer atmosphere. One of the equations there used, the one with subscript unity on page 13, is, as Messrs. Abbot and Fowle of the Smithsonian Institution have kindly pointed out, not generally true, since the temperature of the absorbing medium differs from that of the radiating, and therefore needs some further explanation in this connection. The equation is strictly true for single wave lengths for all objects, and also true for any combination of wave lengths for a black body, but not necessarily true for anything else.

The problem is this: What will be the temperature of a gas in the neighborhood of an infinite black plane whose temperature is 259° C.?

If the atmosphere, or anything else, should be placed between two such planes, then its temperature would become the same as that of the planes themselves, that is, in this case, 259° C. But if instead of being placed between two planes it should be placed near just one such plane, with only empty space beyond, then its condition would be that of the upper atmosphere, and its temperature, less than 259° C., would depend upon its coefficient of absorption for the incident energy and upon its power of radiation.

For the atmosphere these two temperatures differ, as we know by observation, by only about 40° C. Consequently its physical state and its chemical composition would remain the same under the two conditions, and therefore the spectral regions of absorption identical and the coefficients of absorption nearly constant. Besides, the intensity of each radiation from the two planes jointly would be just twice that from but one, and hence the amount of energy absorbed in the one case to that absorbed in the other approximately as 2 to 1. When equilibrium is established, radiation of course is equal to absorption, and the two radiations would therefore be to each other also approximately as 2 to 1.

Now evidently the ratio of such two radiations can be set equal to the ratio of the absolute temperatures raised to some power, n say. But, as explained in the article above referred to, the two absolute

temperatures are known, the one (259° C.) by calculation, the other (218° C.) by observation. Therefore we have

$$\frac{259}{218} = \frac{\sqrt[n]{2}}{1}, \text{ approximately, and } n = 4, \text{ about.}$$

Hence, if we write B for the radiation of a black body at air temperatures and G for the radiation of a portion of the atmosphere at the same temperatures, we can write

$$B = cT^4 \text{ and}$$
$$G = kT^4, \text{ approximately,}$$

in which c and k are constants.

Hence, for temperatures T_1 and T_2 we have,

$$\frac{B_1}{B_2} = \frac{cT_1^4}{cT_2^4} \text{ and } \frac{G_1}{G_2} = \frac{kT_1^4}{kT_2^4},$$

and therefore

$$\frac{B_1}{B_2} = \frac{G_1}{G_2}.$$

Consequently the use in this particular case of the equation with subscript unity, above referred to, is justified. That is, a given alteration of temperature produces about the same proportionate change in air radiation that it does in black body radiation. In other words, the coefficient for air radiation is nearly constant and its temperature exponent approximately 4.

STORM DEPTH, RATE OF MOVEMENT, AND INTENSITY.

By WM. R. BLAIR.

The energy displayed in the storms that continually pass over us is almost entirely due to the absorption by the lower atmosphere of the direct and reflected rays of the sun and of the heat rays of longer wave-length radiated by the earth. The latter radiation is due to the heating of the earth's surface by its absorption of the direct rays of the sun or other causes such as the presence near the surface of radio-active minerals.

Water vapor absorbs the long heat waves readily and upon its vertical distribution in the atmosphere depends to a great extent the altitude at which their energy becomes effective in heating the air and setting it in motion. Observations upon this distribution show that at 2,500 meters the moisture content of the air is one-third what it is at sea level, at 5,000 meters, one-tenth. Most clouds of the cumulus and stratus types form below the latter level. It is to be expected therefore, and we are not disappointed in finding that this lower stratum of air is in continuous and complicated motion, vertical currents as well as horizontal obtaining. Above this stratum the air movement seems to be less complex.

When an air mass is heated to a temperature higher than that of the air about it, as we now see may be the case near the earth's surface, an unstable condition obtains and convection currents set in. A body of air rising to higher levels is cooled by its own expansion as it passes into the rarer atmosphere. This is called adiabatic cooling. If the body of air in question were dry, the rate of the cooling would be about 1° C. per 100 meters of ascent, known as the adiabatic rate. If it contains moisture, it will not cool so rapidly, for the moisture in condensing gives off its latent heat into the air. This effect is a function of the relative humidity and tends to accelerate the upward motion and postpone the return of stable conditions. Sufficient condensation soon takes place, so that heat from this source ceases to offset the adiabatic cooling, and the convection current finds its upper limit. Other moist air coming in from below supports the system thus set up, and the whole moves with the upper westerly wind. This sort of circulation on a larger or smaller scale, more or less modified by other circulations of the same sort, is in progress continually. An almost

unmodified type of it may often be observed during the summer months in the formation of a single cumulus cloud. The cloud formation shows the outlines of the ascending air column. The horizontal air movement is slight at such times and the column nearly vertical.

We should expect to find then that the change of temperature with altitude is less in the lower moist stratum of the atmosphere than in that immediately above it and always, when mean conditions for a sufficiently long time, say a year, are considered, less than the adiabatic rate, some moisture being present at all altitudes. The sounding balloon observations in middle Europe, as compiled by Hann, give the mean gradient up to 3,000 meters as 0.45° C. per 100 meters, while at twice this altitude the temperature change is 0.70° C. per 100 meters.

Within the moist stratum itself, observations on the relative humidity show that the yearly minimum at the earth's surface occurs in the summer months. The result is that condensation begins at higher levels in summer than in winter. The temperature gradient responds to these conditions, being greater near the earth's surface and less near the upper region of the moist stratum in summer than in winter. The temperature gradient is the change in temperature with the altitude. Values closely approximating the adiabatic rate are often found for the first 500 meters above sea level in the summer months. Comparison of the mean temperature gradients as observed in Europe and in this country, at Mount Weather and Blue Hill, points to the fact that condensation takes place at lower levels in western Europe than here. This is reasonable when the comparatively dry surface conditions which obtain on this continent are taken into consideration.

It follows from the above that the moist or storm stratum is (1) deeper in summer than in winter; (2) deeper over a continent than over the ocean or smaller land areas. Convection currents are more sluggish where the relative humidity at the surface is low and therefore the barometric changes are less pronounced (1) in summer than in winter; (2) in continental than in insular climatic conditions. Upon these considerations alone we should expect the deeper storms to be less intense, but this is not in general true; and another factor, viz, the velocity of the upper westerly winds, must be taken into consideration. By storm intensity is meant the suddenness of the changes brought about by the passage of the storm, probably best measured by the barometric changes.

These currents apparently control the rate of motion of the storms. Their velocities are found to vary with altitude, increasing up to heights

of 10,000 or 12,000 meters. They also vary with the seasons. At an altitude of 3,000 to 5,000 meters their mean velocity for January is found to be fully one and one-half times the mean for July. It follows that for a given season the deeper storms move faster, i. e., continental and insular climatic conditions are respectively characterized by more and less rapidly moving storms. The effect of rapid motion upon a storm should be, in general, to intensify it, for the more rapidly it moves the greater the quantity of moist surface air that will be drawn up into it, and consequently the greater the amount of latent heat liberated because of the moisture condensation.

The conclusion is that, for a given location and season, the depth of a storm should indicate something of its rate of movement and consequently of its intensity. This is in accord with the experience at Mount Weather.

It is said that American storms are more intense than those of Europe. If this be true, it is directly because of their more rapid motion and indirectly because of their greater depth.

Summer storms are less intense than those of winter. They are not only deeper but move less rapidly.

Cyclonic storm paths are, in general, found to pass thru the regions of greater surface humidity. They seldom cross the arid or dry mountain regions, but travel along the great river basins, over the Great Lakes, or along the Gulf and ocean coasts.

STATIONARY CLOUDS TO THE LEEWARD OF HILL AND MOUNTAIN RANGES.

By Wm. R. Blair and L. C. Ross.

This phenomenon has been observed and written upon by Clayden and others, but in a more general way than is here attempted. The description of conditions accompanying this particular cloud formation, as they have been observed aloft and at the surface, follows in some detail because of its own interest and the probable similarity in many respects of this and other sorts of wave clouds.

Plate I shows the stationary cloud as seen from the top of the mountain. From this point of view it has the appearance of a long roll characterized by a rather smooth upper and windward surface and a somewhat ragged lower surface. From directly under the cloud, one sees the formation of fragments of cloud to the windward, their drift into the mass and the dissipation of the cloud to the leeward. If the wind direction is not at right angles to the mountain range, there is a slight apparent motion in the whole cloud parallel to the range and at a rate and direction controlled by the component of the wind's velocity parallel to the range. A cross section of the cloud would be in the form of an ellipse, the major axis, in this case the horizontal, being three or four times the length of the minor. The width of clouds observed varies from 1 to 3 kilometers. Sometimes only one cloud forms, more frequently there is a succession of two or three as shown in the illustration. As many as seven have been seen. The horizontal distance, from the mountain top, of the near side of the first cloud varies from 4 to 9 kilometers and the vertical distance of the base from 750 to 1,000 meters.

The top of the range is 310 meters above the valley to the leeward. The valley is rather flat, about 20 kilometers wide and 216 meters above sea level. The rise from the leeward valley to the mountain top is abrupt, being about one meter in five, while the windward slope is more gradual.

Wind direction and velocity, temperature, humidity, and the depression of the dew-point have been recorded on the mountain top in each of the eleven cases observed during the past twenty months, also the temperature and wind direction above the mountain in ten of these cases by means of kites. In a rough way the wind velocity aloft is

approximated by observing the pull of the kites at different altitudes. On one occasion observations were made in the valley at intervals of a kilometer or so from the foot of the mountain out to and below the cloud. The data obtained in this case consists of wind direction and approximate velocity, also temperature, humidity, and depression of the dew-point.

The direction of the wind is always between west and northwest. Its surface velocity is from 11 to 22 meters per second. It is a part of the circulation of an anticyclone the center of which is usually well to the west of Mount Weather tho sometimes to the northwest or southwest. The wind direction does not change much if any with altitude for the first 1,000 meters above the mountain and the velocity usually decreases somewhat up to that level. The temperature falls at about the adiabatic rate up to this level and there begins an inversion of temperature in nine out of ten cases in which upper air observations were made. It is probable that on December 26, 1908, the kite did not rise high enough to carry the instrument into the inversion layer. The mean gradient up to the inversion layer for these ten cases is 1° C. per 100 meters and the mean altitude of the base above the mountain 775 meters, above sea level 1,300 meters, which altitude seems to be the same as the top of the stationary cloud.

On the day in which valley observations were made, March 11, 1909, the wind velocity was found to be 19 meters per second on the mountain top, a slight current up the mountain on the leeward side, 9 to 11 meters per second from the foot of the mountain out to a distance of about 3 kilometers and from there out to 3 or 4 kilometers farther, 4½ to 7 meters per second. This last point was under the cloud. The observations with the psychrometer on the mountain top and in the valley, made at different times while the stationary cloud lasted, showed the dew-point to be −5° C., a mean depression of 10.8° C. from the surface temperature of the valley, 7.7° C. from that of the mountain top. Two rough observations made upon the altitude of the cloud base at different times on this day gave the results, 770 and 840 meters above the mountain top—a mean of 800—about 1,100 above the valley. The temperature in this cloud base, if the adiabatic rate of cooling is assumed, would be between −5° C. and −6° C. Three clouds formed on this day. The horizontal distance of the first from the mountain top was 8.8 kilometers. The distance between the first and second was less than that between the mountain top and the first; that between the second and third apparently less than between the first and second. The distance from the mountain top to the third

cloud did not exceed 20 kilometers. These distances seem to be dependent on the wind velocity, being greater for higher velocities.

The above data seems to point to the fact that stationary clouds to the leeward of hill and mountain ranges form in winds of high velocity which have a sufficiently strong upward component to insure the cooling of the surface air to its dew-point at some altitude below the inversion of temperature which is observed to accompany surface conditions suitable for cloud formation. The first cloud is probably due to the upward deflecting effect of the hill or mountain range. The cooling effect due to expansion of the air mass as it leaves the top of the ridge seems to be negligable. On this supposition, the cloud is bounded on the upper surface by the base of the temperature inversion, on the windward side and its lower surface by the depression of the dew-point on the mountain top and the rate of cooling with altitude, on the leeward by the amount of heat liberated in the process of moisture condensation which forms the cloud itself. The air moving away from the cloud on the leeward side has a temperature above the dew-point and considerably above that of the surrounding air. It will therefore have an upward as well as a horizontal component in its velocity. This upward velocity will be imparted to the air below with the result that a second cloud forms farther out over the valley. The position of the near edge of this second cloud is determined by the horizontal distance the second supply of surface air travels before its upward component brings it to the level of its dew-point temperature. A similar explanation may be offered for each successive cloud. The successive cloud bases seem to be on the same level. The variation in the horizontal wind velocities as observed in the valley is probably due in part to this upward component which should have about the same velocity at the leeward of each cloud, and in part to the fact that the sheltered air in the valley is being set in motion by the current of high velocity passing over it.

Other explanations are offered for this form of cloud. One is that the cloud forms at the boundary between warm and cold horizontal strata of air; another, that the successive bars of cloud are formed in the ascending parts of a succession of standing waves into which the air current is thrown by its passage over the hill or mountain range. Neither of these explanations nor a combination of them seems to fit the observations upon temperature, humidity, and wind velocity. Observations upon the latter as well as those upon distances between successive clouds would be especially hard to reconcile to the standing wave hypothesis.

UPPER AIR TEMPERATURES FOR OCTOBER, NOVEMBER, AND DECEMBER.

By the Aerial Section; W. R. BLAIR in charge.

In this period, captive balloons were used but five times, the last occasion being November 2. On all other days the winds were sufficient for kite flying. The prevailing wind, which was southeast in September, became northwest in October and remained decidedly so during the other two months. The mean surface wind velocity, which was 4.5 meters per second in September, increased during these three months, being 5.5 meters per second in October, 7.1 in November, and 7.5 in December. Barometric changes became correspondingly more frequent and more pronounced, and with them the rise and fall of the upper air isotherms as shown in Charts VII, VIII, IX, X, XI, and XII was more abrupt and of greater range. Comparison of the December and July charts clearly shows these differences and, in addition, the fact that the diurnal variation of the air temperatures up to about one mile above sea level, while easily observed in July, is hardly apparent in the more turbulent conditions prevailing in December.

Figs. 4, 5, and 6, are charts of the mean hourly temperatures at Audley, Trapp, and Mount Weather for these three months. The mean diurnal variation of temperature for the last two months is less at all stations than for the month preceding. This agrees well with the following data on cloudiness during the period, altho the increased air movement above mentioned must have had its effect in the same sense.

Month.	Number of days.			Mean Cloudiness.
	Clear.	Partly cloudy.	Cloudy.	
October	18	5	8	3.8
November	13	9	8	4.9
December	8	9	14	6.4

The Audley temperatures have a greater daily range than either those of Trapp or Mount Weather, due to the comparatively low minimum occurring there between 6 and 8 a. m. in clear weather, there being considerably less air movement at the valley station than on the mountain top.

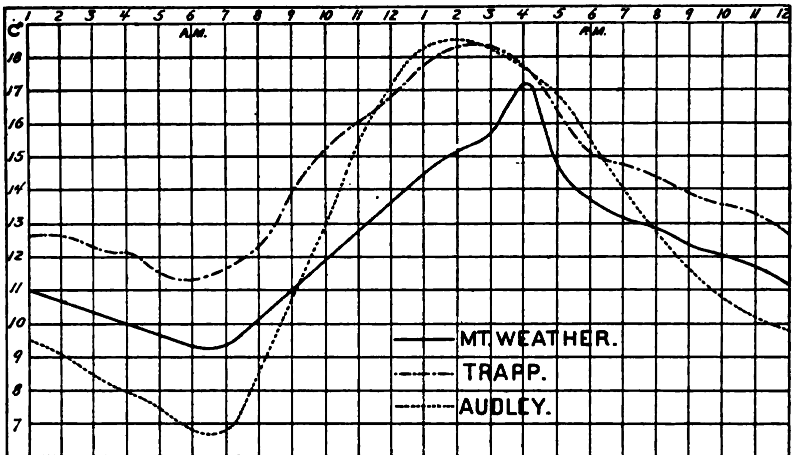


Fig. 4.—Mean hourly temperatures, October, 1908.

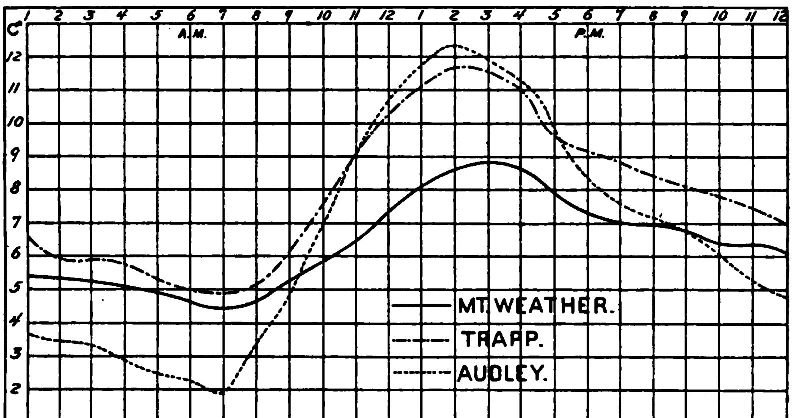


Fig. 5.—Mean hourly temperatures, November, 1908.

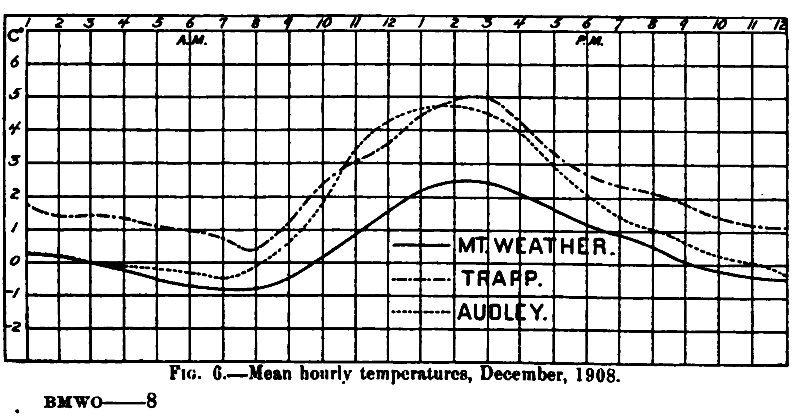


Fig. 6.—Mean hourly temperatures, December, 1908.

The observations made at Mount Weather afford very good opportunities to study the temperatures of high-pressure areas. As the anticyclone approaches there is a decided fall in temperature beginning at the earth's surface. This fall is due to the downward current of air causing the high pressure. The necessary spreading out of the colder body of air when its descent is stopt by the earth's surface gives rise to a peculiar temperature gradient. An inversion of temperature occurs just above the surface and, as shown by succeeding observations, rises rapidly and disappears, giving place to nearly isothermal conditions which extend to 3 or 4 kilometers above sea level from the mountain top, more frequently from 500 to 1,000 meters above it. While the barometer continues to rise, a second inversion of temperature begins at higher levels and, as shown by succeeding observations, the altitude at which the maximum temperature is found decreases rapidly. By the time the barometer has become stationary, i. e., the high has become central, the temperature at the surface is higher than at any point above. The first of these inversions, as already intimated, is due to the coming in at the surface of the descending cold air of the incoming high and is of short duration.

The second is due to the approach of the warmer center of the high-pressure area, which seems to incline forward. The warming up of the air in this center at the lower levels is adiabatic, being due to the compression of the descending air mass, and is the reverse of the effect observed in the center of the low-pressure area, i. e., cooling of the air at higher levels due to its expansion in rising. If the barometer remain high and stationary for any length of time, as it did from October 4 to 6, inclusive, or in general, when clear, quiet conditions prevail, the diurnal variation of the temperature extending to about 1,500 meters above sea level is clearly apparent. At such a time no vertical and usually rather light horizontal currents obtain, and the absence of clouds or much moisture permits a larger percentage of the sun's energy to reach the earth by day and free radiation from the earth's surface by night. Inversions of temperature are frequently observed above other parts of the high-pressure area than those mentioned. These are apparently due, as has been pointed out in a previous article (this Bulletin, p. 26, Part 1, Vol. II), to the overhanging of adjacent low-pressure areas. The opinion, held by many, that the axes of anticyclones are inclined forward on account of the greater velocity of the winds aloft, which control their motion, seems to be supported by these observations on upper air temperatures.

In low-pressure areas the temperature gradient which tends to obtain is rather large, approximating the adiabatic rate of cooling. This condition is modified by the presence of moisture in the air. The point at which the moisture of the air mass (either ascending or moving to colder latitudes) begins to condense is marked by an abrupt change to somewhat irregular isothermal conditions. The latter may begin at the earth's surface as in the case of a fog or light rain, or higher up depending on the altitude at which condensation is taking place. As is to be expected, this altitude depends in general on the quarter of the low in which the observation is being made, also on the distance from its center. These isothermal conditions are easily distinguishable from those obtaining in the fore part of a high, being characterized by small inversions of temperature, several of which are often observed one above another. Such inversions are not persistent, often disappearing between the time of the ascent and descent of the kite. They no doubt result from condensation, which must occur as the result of any slight fall in temperature due to whatever cause.

Observations upon which to base the above statement of the relations between temperature and pressure are numerous and may be found in almost any of the isothermal charts. The first five days in October, see isothermal Chart VII, show the inversion due to the approaching high pressure area on October 2, the inversion due to the warmer center of the area on October 2 and 3 and the undisturbed diurnal variation of the temperature on October 5.

For the following observations, made within the cyclone, see isothermal Charts VIII and XI. The flight of December 7 was made to the right and in front of the center of the low. Light rain and fog prevailed. Apparently the depth of this fog or low cloud layer was 1,750 meters. That of October 29 was to the left and in front of the storm center. Light rain and lowering clouds, the latter reaching the mountain top before the end of the flight, prevailed. For the flight of October 30, the observatory was to the right and back of the center of of the low-pressure area. There were from three to eight-tenths strato-cumulus clouds present and the kite entered this cloud layer at an altitude of 2,300 meters. A flight to the right and well back in the cyclone was made on October 27. No low clouds and only a few alto-cumulus and cirrus were present. The cloud layer was not reached by the kite. The temperature distribution observed by means of these kite flights is characteristic. The irregular isothermal conditions spoken of above may be noted, beginning at the earth's surface in the

first and second and at the cloud level in the third in the order mentioned, while the gradient outside the condensation layer shows approximately the adiabatic rate of cooling with altitude. The slight inversion observed between 7 and 8 a. m. on October 27 near the surface is characteristic of clear mornings.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
October 1, 1908:	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
5:24 p. m.	11.2	100	nw.	8.9	526	11.2	100	nw.	8.9
5:31 p. m.	11.2	100	nw.	8.9	846	9.8	......	wnw.	....
5:38 p. m.	11.2	100	nw.	8.5	1,177	9.0	......	w.	....
5:48 p. m.	11.2	100	nw.	8.5	1,573	7.2	......	w.	....
5:55 p. m.	11.2	100	nw.	8.5	1,947	4.6	......	w.	....
6:03 p. m.	11.2	100	nw.	7.6	2,108	4.4	......	w.	....
6:35 p. m.	10.9	100	nw.	6.7	1,657	3.0	......	w.	....
7:00 p. m.	10.6	100	nw.	3.6	1,132	7.8	......	nw.	....
7:12 p. m.	10.6	100	nw.	2.2	931	10.4	......	nw.	....
7:18 p. m.	10.6	100	w.	2.2	526	10.6	100	w.	2.2
October 2, 1908:									
8:36 a. m.	5.8	78	nw.	9.4	526	5.8	78	nw.	9.4
8:41 a. m.	6.1	78	nw.	9.4	948	2.0	......	nw.	....
9:16 a. m.	6.6	68	nw.	9.8	2,166	1.9	......	nw.	....
9:26 a. m.	6.6	68	nw.	9.4	2,570	0.5	......	nw.	....
10:15 a. m.	7.1	62	nw.	12.1	3,205	0.7	......	nw.	....
10:29 a. m.	7.2	58	nw.	9.4	3,418	3.1	......	nw.	....
10:56 a. m.	7.7	54	nw.	13.0	4,082	0.2	......	nw.	....
11:17 a. m.	8.8	54	nw.	8.9	4,451	− 2.6	......	nw.	....
12:40 p. m.	10.3	48	nw.	10.8	4,912	− 5.9	......	nw.	....
1:15 p. m.	10.0	44	nw.	7.6	4,078	0.6	......	nw.	....
3:38 p. m.	10.9	44	nw.	10.3	2,814	5.2	......	nnw.	....
4:00 p. m.	10.6	45	nw.	9.4	1,681	0.5	......	nw.	....
4:15 p. m.	10.4	44	nw.	8.0	1,294	3.5	......	nw.	....
4:21 p. m.	10.4	44	nw.	7.6	974	6.0	......	nw.	....
4:31 p. m.	10.4	44	nw.	8.0	526	10.4	44	nw.	8.0
October 3, 1908:									
7:08 a. m	1.3	87	nw.	6.7	526	1.3	87	nw.	6.7
7:28 a. m	2.1	82	nw.	6.7	840	9.2	......	n.	....
7:47 a. m	2.9	81	nw.	5.8	1,265	7.5	......	nne.	....
8:00 a. m.	3.4	75	nw.	5.4	1,705	8.5	......	nne.	....
8:16 a. m.	4.1	78	nw.	6.8	2,169	8.8	......	nne.	....
9:11 a. m.	5.0	77	nw.	7.6	2,728	8.2	......	ne.	....
10:13 a. m.	7.0	67	nw.	6.8	3,152	5.9	......	ne.	....
10:47 a. m.	8.3	66	nw.	5.4	2,615	8.0	......	ne.	....
11:01 a. m.	8.7	56	nw.	6.7	1,945	9.3	......	ne.	....
11:12 a. m.	8.7	56	nw.	5.4	1,006	9.2	......	nne.	....
11:25 a. m.	8.9	54	nw.	4.9	526	8.9	54	nw.	4.9

October 1, 1908.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 3,550 m., at maximum altitude.

Rain began at 2:44 p. m. and continued to 7:07 p. m.; fog set in at 4:30 p. m. and continued to 6:50 p. m., light most of the time. Clouds, when visible, were moving from the southwest.

Pressure was high over Iowa and low over Ontario and southeast of Florida.

October 2, 1908.—Seven kites were used; lifting surface, 44.4 sq. m. Wire out, 10,000 m.; at maximum altitude, 8,992 m.

Light haze prevailed during the flight. From 8/10 to 1/10 St.-Cu. moving from the northwest were visible until 3 p. m. The sky was cloudless thereafter.

A high was central north of Lake Huron and a low over Nova Scotia.

October 3, 1908.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 6,218 m.; at maximum altitude, 5,014 m.

The sky was cloudless.

High pressure, central over western Pennsylvania, covered the eastern half of the United States.

RESULTS OF CAPTIVE BALLOON ASCENSION.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
October 5, 1908:									
3:35 p. m	16.7	55	se.	2.2	526	16.7	55	se.	2.2
3:45 p. m	17.8	52	se.	2.2	1,222	12.2	......	ne.	....
3:54 p. m	20.5	44	se.	1.8	1,666	10.8	......	ne.	....
4:15 p. m.	18.4	58	se.	1.8	1,299	12.8	.....	ne.	....
4:40 p. m.	17.4	58	se.	1.8	1,024	13.5	......	e.	....
4:50 p. m	16.4	62	se.	1.8	526	16.4	62	se.	1.8

RESULTS OF KITE FLIGHTS.

October 6, 1908:									
9:37 a. m.	13.8	71	se.	4.0	526	13.8	71	se.	4.0
9:57 a. m.	13.8	70	se.	3.6	886	11.0	......	se.	....
11:06 a. m.	14.4	62	se.	3.1	1,171	13.8	......	sse.	....
11:19 a. m.	14.7	62	se.	3.6	526	14.7	62	se.	3.6
October 7, 1908:									
1:54 p. m	13.4	81	se.	2.7	526	13.4	81	se.	2.7
2:00 p. m	13.6	81	se.	2.7	742	12.2	......	ssw.	....
2:25 p. m	14.8	78	se.	4.0	867	14.8	......	sw.	....
3:20 p. m	15.6	73	se.	4.5	1,109	17.7	......	sw.	....
3:51 p. m	15.9	71	se.	5.4	1,609	14.2	......	ssw.	....
4:00 p. m	15.8	71	se.	4.9	1,190	16.7	......	ssw.	....
4:09 p. m	15.9	72	se.	4.9	1,136	14.2	......	s.	....
4:20 p. m	15.9	70	se.	5.8	864	12.9	......	se.	....
4:24 p. m	15.6	70	se.	6.7	526	15.6	70	se.	6.7

October 5, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,000 m. Light haze was present during the ascension. The sky was cloudless.

Pressure was high over the upper St. Lawrence Valley and low over western Kansas.

October 6, 1908.—Three kites were used; lifting surface, 19.4 sq. m. Wire out, 1,500 m., at maximum altitude.

Light haze was observed during the flight. The sky was cloudless.

A low was central north of Lake Superior. High pressure prevailed along the north Atlantic coast.

October 7, 1908.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 2,480 m.; at maximum altitude, 1,650 m.

The sky was cloudless.

High pressure was central over southern New England; low pressure southeast of Florida. Pressure was relatively low over Lake Huron.

RESULTS OF KITE FLIGHTS.

7:17 a. m.	13.1	85	s.	4.5	526	13.1	85	s.	4.5
7:29 a. m.	13.4	84	sw.	5.8	780	16.0	......	ssw.	......
7:55 a. m.	13.9	83	s.	4.5	942	14.4	......	ssw.	......
8:37 a. m.	14.4	80	s.	4.0	1,532	12.2	......	sw.	......
10:00 a. m.	15.0	78	se.	4.5	1,791	10.8	......	sw.	......
10:33 a. m.	15.7	81	se.	4.9	2,051	9.2	......	ssw.	......
11:56 a. m.	18.0	70	se.	5.4	2,398	6.8	......	ssw.	......
12:11 p. m.	18.3	67	se.	4.5	1,869	9.2	......	ssw.	......
12:37 p. m.	18.8	67	se.	4.5	1,550	12.2	......	ssw.	......
12:55 p. m.	19.1	65	se.	5.4	1,805	14.1	......	ssw.	......
1:16 p. m.	19.8	64	se.	4.5	1,146	15.2	......	s.	......
1:22 p. m.	19.8	64	s.	4.5	886	15.2	......	sse.	......
1:44 p. m.	18.9	62	se.	4.9	526	18.9	62	se.	4.9
October 9, 1908:									
8:21 a. m.	11.1	100	n.	4.5	526	11.1	100	n.	4.5
8:30 a. m.	11.1	100	n.	4.5	965	11.1	......	n.	......
8:58 a. m.	11.4	100	n.	4.5	1,366	11.0	......	n.	......
9:30 a. m.	12.6	91	n.	4.5	1,838	8.0	......	ne.	......
10:54 a. m.	12.8	91	nw.	4.0	2,109	7.0	......	nne.	......
11:41 a. m.	12.6	91	n.	4.0	2,791	4.1	......	ne.	......
12:05 p. m.	14.4	88	nw.	4.0	2,395	6.2	......	ne.	......
12:19 p. m.	14.4	87	nw.	5.4	2,058	7.1	......	ne.	......
12:27 p. m.	14.2	89	nw.	5.4	1,745	9.0	......	ne.	......
12:33 p. m.	14.1	89	nw.	4.0	1,277	11.0	......	ne.	......
12:46 p. m.	14.3	89	nw.	4.0	854	11.8	......	nne.	......
12:58 p. m.	14.3	89	nw.	4.5	526	14.3	89	nw.	4.5

October 8, 1908.—Six kites were used; lifting surface, 38.3 sq. m. Wire out, 5,000 m.; at maximum altitude, 3,500 m.

Ci. moving from the southwest increased in amount from 3/10 at the beginning to 8/10 at the end of the flight. From 1/10 to 2/10 low St. moving from the south were present after 10:40 a. m.

High pressure was central over Nebraska and off the southern New England coast, and low pressure over the lower St. Lawrence and east of southern Florida.

October 9, 1908.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 6,000 m.; at maximum altitude, 4,420 m.

Dense fog prevailed until 8:50 a. m. and light fog until 9:30 a. m. From 10/10 to 7/10 A.-St. were visible after 8:50 a. m. and 1/10 to 3/10 St. moving from the northwest after 9:30 a. m.

A low was central over Georgia and South Carolina and a high over Kansas.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
October 10, 1908:									
6:59 a. m.	8.2	88	se.	7.6	526	8.2	88	se.	7.6
7:09 a. m.	8.3	90	e.	7.6	854	8.4	......	e.	....
7:25 a. m.	8.3	91	e.	7.6	1,175	7.1	......	ese.	....
7:50 a. m.	8.3	93	e.	8.5	1,518	4.9	......	ese.	....
8:09 a. m.	7.8	93	e.	5.8	2,287	3.9	......	ese.	....
8:20 a. m.	7.9	95	se.	6.7	2,356	2.9	......	se.	....
8:38 a. m.	8.3	93	e.	5.8	2,760	3.5	......	se.	....
9:04 a. m.	8.3	93	se.	5.4	3,412	0.0	......	se.	....
9:16 a. m.	8.3	93	e.	4.9	3,741	−0.5	......	se.	....
10:14 a. m.	8.8	94	e.	6.3	4,182	−2.3	......	sse.	....
10:55 a. m.	8.9	95	se.	7.6	4,016	−3.2	......	sse.	....
11:17 a. m.	9.0	98	se.	7.2	3,678	0.3	......	sse.	....
11:40 a. m.	9.1	98	e.	5.8	3,221	2.8	......	sse.	....
11:55 a. m.	9.4	96	e.	5.8	2,923	2.4	......	sse.	....
12:21 p. m.	10.0	98	e.	5.8	2,303	5.7	......	se.	....
12:30 p. m.	10.1	98	e.	6.8	526	10.1	98	e.	6.8
October 12, 1908:									
9:32 a. m.	5.0	60	nw.	8.9	526	5.0	60	nw.	8.9
9:39 a. m.	5.4	59	nw.	8.9	973	0.8	......	nnw.	....
9:49 a. m.	5.6	58	nw.	8.9	1,136	5.3	......	nnw.	....
10:14 a. m.	5.6	62	nw.	7.2	2,057	2.9	......	nnw.	....
11:36 a. m.	7.4	55	nw.	5.4	2,567	0.8	......	nnw.	....
11:58 a. m.	7.6	53	nw.	4.0	2,195	1.8	......	nnw.	....
12:10 p. m.	7.4	54	nw.	5.8	1,790	2.7	......	nnw.	....
12:21 p. m.	7.8	48	nw.	6.3	1,379	4.4	......	nnw.	....
12:27 p. m.	8.2	47	nw.	6.3	1,100	2.4	......	nnw.	....
12:34 p. m.	8.4	47	nw.	6.3	849	4.1	......	nnw.	....
12:40 p. m.	8.6	48	nw.	5.4	526	8.6	48	nw.	5.4

RESULTS OF CAPTIVE BALLOON ASCENSION.

October 13, 1908:									
4:09 p. m.	11.7	42	se.	2.2	526	11.7	42	se.	2.2
4:25 p. m.	13.3	43	se.	1.8	2,631	4.8	......	nnw.	....
4:35 p. m.	12.8	44	se.	2.7	2,140	6.8	......	nnw.	....
4:50 p. m.	12.2	43	se.	2.7	1,531	8.8	......	ssw.	....
5:00 p. m.	11.1	45	se.	3.1	1,126	10.0	......	ssw.	....
5:16 p. m.	10.3	45	se.	3.6	526	10.3	45	se.	3.6

October 10, 1908.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 7,500 m.; at maximum altitude, 7,167 m.

The sky was overcast with St. moving from the southeast. Light fog continued thru the flight. The fog became dense and rain began just after the flight. The head kite entered the clouds at 7:08 a. m.

High pressure was central over Lake Champlain and low pressure over Lake Superior. Pressure was relatively low over the South Atlantic States.

October 12, 1908.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 6,300 m.; at maximum altitude, 5,350 meters.

No clouds were observed.

High pressure, central between the Lakes and the Ohio Valley, covered the United States east of the Rocky Mountains.

October 13, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,195 m.

A few A. St. clouds were visible near the horizon.

A high was central over the Middle Atlantic coast States and a low over the Canadian southwest.

RESULTS OF KITE FLIGHTS.

	On Mount Weather, Va., 526 m.				At different heights above sea.				
7:23 a. m.	7.2	63	nw.	6.7	526	7.2	63	nw.	6.7
7:29 a. m.	7.2	65	nw.	6.7	778	18.1	......	nw.	....
7:39 a. m.	7.8	61	w.	6.3	985	11.7	......	nw.	....
8:00 a. m.	8.2	62	w.	6.8	1,146	13.9	......	nw.	....
9:52 a. m.	12.3	54	sw.	1.8	1,552	10.5	......	n.	....
10:25 a. m.	13.3	50	w.	1.8	1,124	11.2	......	nw.	....
10:37 a. m.	14.4	57	se.	1.8	892	12.4	......	nw.	....
10:42 a. m.	14.7	54	sw.	1.8	526	14.7	54	sw.	1.8
October 15, 1908:									
7:16 a. m.	14.8	48	w.	8.0	526	14.8	48	w.	8.0
7:24 a. m.	14.8	48	w.	8.0	680	8.5	......	w.	....
8:39 a. m.	16.8	45	w.	8.9	1,348	16.9	......	nw.	....
9:38 a. m.	17.9	48	w.	7.2	1,645	13.2	......	nw.	....
10:34 a. m.	20.0	48	w.	8.5	2,083	10.0	......	wnw.	....
10:46 a. m.	20.0	43	nw.	8.5	1,623	14.1	......	wnw.	....
10:57 a. m.	19.7	43	w.	7.2	1,324	16.8	......	nw.	....
11:16 a. m.	20.3	43	w.	8.6	936	17.1	......	wnw.	....
11:25 a. m.	20.6	44	[illegible]	8.5	526	20.6	44	w.	8.5
October 16, 1908:									
7:23 a. m.	15.9	56	nw.	5.8	526	15.9	56	nw.	5.8
8:49 a. m.	18.3	58	nw.	4.9	727	25.8	......	nw.	....
11:21 a. m.	20.6	42	n.	3.6	1,110	22.0	......	n.	....
11:37 a. m.	21.1	40	nw.	4.5	526	21.1	40	nw.	4.5

RESULTS OF CAPTIVE BALLOON ASCENSION.

October 17, 1908:									
4:25 p. m.	23.3	30	n.	3.1	526	23.3	30	n.	3.1
4:30 p. m.	23.2	31	n.	3.1	1,819	19.8	......	se.	....
4:42 p. m.	23.3	33	n.	3.6	1,602	15.4	......	e.	....
4:50 p. m.	22.9	33	n.	3.6	1,282	19.1	......	e.	....
5:20 p. m.	23.1	24	ne.	3.6	876	21.2	......	ene.	....
5:26 p. m.	23.1	24	ne.	3.1	526	23.1	24	ne.	3.1

October 14, 1908.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 3,600 m; at maximum altitude, 2,660 m.

No clouds were visible.

High pressure, central over West Virginia, covered the eastern and southern parts of the country.

October 15, 1908.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 7,285 m.; at maximum altitude, 4,999 m.

From 1/10 to 3/10 Ci.-Cu. moving from the west-northwest were visible during the flight.

A high was central over West Virginia and a low over Manitoba.

October 16, 1908.—Five kites were used; lifting surface, 32.5 sq. m. Wire out, 3,000 m.; at maximum altitude, 2,000 m.

Light haze prevailed thruout the flight; no clouds were visible.

Pressure was high over West Virginia and low over Colorado.

October 17, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 2,134 m.

During the ascension 5 Ci. moving from the north were present.

An area of high pressure was central over the station and a trough of low pressure extended from Michigan southwestward.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
October 19, 1908:	°C.	%		Meters p. s.	Meters.	°C.	%		Meters p. s.
10:38 a. m.	18.6	49	nw.	4.9	526	18.6	49	nw.	4.9
10:53 a. m.	20.0	47	nw.	4.9	844	17.6	......	nnw.	....
11:10 a. m.	17.8	56	nw.	5.4	1,244	15.5	......	n.	....
11:30 a. m.	20.0	47	nw.	4.9	1,625	12.0	......	nne.	....
11:57 a. m.	22.2	42	nw.	5.4	1,993	8.5	......	nne.	....
1:00 p. m.	22.2	49	nw.	5.8	3,015	1.0	......	nne.	....
2:12 p. m.	22.8	50	nw.	5.4	3,469	0.5	......	nne.	....
3:03 p. m.	23.1	53	n.	5.4	2,500	5.2	......	nne.	....
3:29 p. m.	21.7	56	n.	4.0	1,901	9.5	......	nne.	....
3:40 p. m.	21.7	56	n.	4.5	1,536	11.6	......	n.	....
3:57 p. m.	21.4	57	n.	3.6	1,154	14.5	......	n.	....
4:05 p. m.	21.1	59	ne.	3.1	900	17.5	......	n.	....
4:17 p. m.	21.1	59	ne.	3.1	526	21.1	59	ne.	3.1
October 20, 1908:									
8:06 a. m.	7.8	72	ne.	4.5	526	7.8	72	ne.	4.5
8:24 a. m.	7.8	72	ne.	4.9	932	8.7	......	ene.	....
8:40 a. m.	7.7	72	ne.	4.9	1,213	2.9	......	e.	....
11:02 a. m.	8.5	71	e.	4.9	1,737	1.6	......	ne.	....
11:22 a. m.	8.3	68	ne.	5.4	1,339	3.6	......	ne.	....
11:40 a. m.	8.6	68	e.	4.5	1,117	4.6	......	ene.	....
11:44 a. m.	8.7	68	e.	4.5	925	4.9	......	e.	....
11:57 a. m.	9.2	67	e.	4.5	526	9.2	67	e.	4.5
October 21, 1908:									
7:26 a. m.	5.3	70	ne.	4.5	526	5.3	70	ne.	4.5
7:40 a. m.	5.6	70	e.	4.5	827	2.2	......	ene.	....
9:28 a. m.	8.8	64	e.	4.9	1,821	− 1.6	......	e.	....
9:38 a. m.	7.2	65	e.	4.5	2,456	8.3	......	ene.	....
9:58 a. m.	6.9	71	nw.	1.3	1,850	11.3	......	e.	....
10:10 a. m.	7.2	70	nw.	1.3	1,182	− 0.2	......	e.	....
10:20 a. m.	7.7	70	ne.	1.8	876	2.4	......	ene.	....
10:30 a. m.	7.8	69	ne.	1.8	526	7.8	69	ne.	1.8

October 19, 1908.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 6,000 m.; at maximum altitude, 5,500 m.

Dense haze prevailed during the flight.

A high was central over Lake Superior and a low over Colorado.

October 20, 1908.—Six kites were used; lifting surface, 38.3 sq. m. Wire out, 4,880 m.; at maximum altitude, 2,500 m.

At the beginning St. moving from the east covered the sky, and the haze was nearly dense. Clouds and haze became lighter after 10 a. m. The head kite was hidden in St. and haze from 8:35 to 10 a. m., and was obscured at intervals until 11 a. m.

High pressure, central over the St. Lawrence Valley, covered the United States east of the Mississippi. A marked depression lay over North Dakota.

October 21, 1908.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 3,450 m.; at maximum altitude, 3,200 m.

A standing cloud was visible over the Loudoun Valley until 9:30 a. m. From 9:30 a. m. until the end of the flight from 3/10 to 9/10 St. were visible moving from the east at an elevation of about 762 m.

A high was central over the St. Lawrence and a low over Manitoba.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
October 22, 1908:									
7:19 a. m.	6.9	89	e.	7.2	526	6.9	89	e.	7.2
7:31 a. m.	6.9	89	e.	7.2	881	5.4	......	ese.	....
9:12 a. m.	8.1	85	e.	6.7	1,297	4.5	......	e.	....
9:56 a. m	8.9	85	e.	7.6	1,631	7.0	......	e.	....
10:18 a. m.	9.1	82	e.	5.8	1,376	4.4	......	e.	....
10:33 a. m.	9.3	81	e.	6.3	878	7.4	......	e.	....
10:40 a. m.	9.4	80	e.	5.4	526	9.4	80	e.	5.4
October 23, 1908:									
1:29 p. m.	13.3	100	e.	7.2	526	13.3	100	e.	7.2
1:34 p. m.	13.3	100	e.	7.2	878	11.1	......	ene.	....
1:46 p. m.	13.9	94	e.	7.6	1,216	10.0	......	e.	....
1:55 p. m.	14.3	94	se.	8.0	1,494	8.7	......	e.	....
2:18 p. m.	15.4	85	e.	9.4	2,021	7.6	......	ese.	....
2:57 p. m.	15.6	85	se.	8.0	2,481	8.9	......	ese.	....
3:20 p. m.	15.6	86	e.	8.5	2,996	6.0	......	ese.	....
3:30 p. m.	15.6	85	e.	8.5	2,693	7.0	......	ese.	....
3:50 p. m.	15.6	86	e.	8.5	2,080	9.2	......	e.	....
4:00 p. m.	15.3	85	e.	8.9	1,936	7.5	......	e.	....
4:20 p. m.	15.8	89	e.	8.9	1,164	10.9	......	ene.	....
4:30 p. m.	15.3	89	e.	8.5	918	12.5	......	ene.	....
4:36 p. m.	15.2	90	e.	8.5	526	15.2	90	e.	8.5
October 24, 1908:									
10:36 a. m	15.6	100	se.	4.0	526	15.6	100	se.	4.0
10:52 a. m	15.7	100	s.	4.0	912	13.1	......	se.	....
11:28 a. m	15.6	100	se.	3.6	1,467	10.2	......	se.	....
11:50 a. m	15.9	100	s.	4.9	1,668	9.1	......	se.	....
12:03 p. m	16.0	100	se.	4.5	1,387	10.1	......	se.	....
12:27 p. m	15.9	100	se.	4.9	1,107	9.1	......	se.	....
12:37 p. m	16.1	100	se.	5.4	782	13.0	......	se.	....
12:39 p. m	16.1	100	se.	5.4	526	16.1	100	se.	5.4

October 22, 1908.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 3,688 m.; at maximum altitude, 2,438 m.

The sky was overcast with St. clouds moving from the east. The leading kite entered the base of the clouds at an altitude of 881 m., and was only occasionally visible thereafter until some three hours later, when it emerged from the cloud base in descending at an altitude of about 1,219 m.

Pressure was high over Vermont and Wyoming and low southeast of Florida and over Texas.

October 23, 1908.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 6,096 m.; at maximum altitude, 4,572 m.

The sky was covered with clouds moving from the east as follows: St. until 3:50 p. m., Ni. from 3:50 to 4:20 p. m., and St. from 4:20 p. m. until the end of the flight. Light rain fell from 3:50 to 4:20 p. m.

A high was central over Vermont and New Hampshire and a low over the South Carolina coast.

October 24, 1908.—Two kites were used; lifting surface, 10.8 sq. m. Wire out, 2,698 m.; at maximum altitude, 2,591 m.

Dense fog moving from the southeast and light rain prevailed.

A well developed low was central over Iowa. Pressure was high over New England. At 8 a. m. rain was falling over the Mississippi Valley and the Middle Atlantic States.

RESULTS OF CAPTIVE BALLOON ASCENSION.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
October 26, 1908:									
5:38 p. m	17.2	62	s.	2.2	526	17.2	62	s.	2.2
5:44 p. m	17.5	68	se.	2.2	1,101	15.2	......	ssw.	....
7:00 p. m	17.2	70	se.	2.2	526	17.2	70	se.	2.2

RESULTS OF KITE FLIGHTS.

Date and hour.	Air temperature.	Rel. hum.	Dir.	Velocity.	Height.	Air temperature.	Rel. hum.	Dir.	Velocity.
October 27, 1908:									
7:35 a. m	10.6	81	nw.	4.9	526	10.6	81	nw.	4.9
7:40 a. m	10.6	81	nw.	4.5	792	12.0	......	nnw.	....
7:58 a. m	10.9	77	nw.	3.6	1,138	11.0	......	nw.	....
8:38 a. m	11.7	73	nw.	3.6	2,039	5.0	......	wsw.	....
9:33 a. m	13.7	69	nw.	1.8	2,605	− 1.9	......	wsw.	....
10:23 a. m	15.1	68	nw.	1.8	2,927	− 5.0	......	sw.	....
10:33 a. m	14.7	68	nw.	2.7	2,548	− 2.0	......	sw.	....
10:50 a. m	15.0	68	nw.	2.2	1,849	4.9	......	w.	....
10:59 a. m	15.6	63	nw.	3.1	1,042	11.0	......	nw.	....
11:13 a. m	14.7	66	nw.	3.1	526	14.7	66	nw.	3.1
October 28, 1908:									
4:03 p. m	9.4	100	nw.	4.5	526	9.4	100	nw.	4.5
4:25 p. m	8.7	100	nw.	7.2	794	6.5	......	nw.	....
4:34 p. m	8.3	100	nw.	6.3	1,010	5.0	......	nw.	....
5:24 p. m	8.3	100	nw.	8.9	1,130	5.5	......	nw.	....
5:39 p. m	8.4	98	nw.	8.5	864	6.0	......	nw.	....
5:44 p. m	8.5	98	nw.	8.5	526	8.5	98	nw.	8.5

October 26, 1908.—One balloon was used, capacity, 25.6 cu. m. Wire out, 1,524 m.

During the ascension 2/10 St.-Cu. moving from the southwest were present.

Pressure was high over New Brunswick and low over Minnesota, with a secondary depression over Lake Ontario.

October 27, 1908.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 4,877 m.; at maximum altitude, 3,962 m.

About 1/10 A.-Cu. moving from the southwest were visible during the flight, and from 1/10 to 3/10 Ci. from the southwest after 10:30 a. m.

A slight barometric depression was central over Illinois and a moderate high over the south Atlantic coast.

October 28, 1908.—Two kites were used; lifting surface, 13.1 sq. m. Wire out, 2,560 m.; at maximum altitude, 1,067 m.

Light rain fell until 4:45, and dense fog continued until 5:05 p. m., after which the kites were visible against a cover of St. moving from the southwest.

At 8 a. m. low pressure was central over Florida. Another low lay over Lake Superior. Pressure was high over the middle Atlantic and New England seaboard. Rain was general east of the Mississippi.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m. Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.	At different heights above sea. Height.	Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
October 29, 1908:									
7:21 a. m.	4.3	96	nw.	5.8	526	4.3	96	nw.	5.8
7:32 a. m.	4.4	95	n.	5.8	794	4.8	......	n.	....
7:41 a. m.	4.5	95	nw.	5.4	1,143	4.2	......	n.	....
7:55 a. m.	4.6	98	nw.	5.4	1,632	2.6	......	ne.	....
8:28 a. m.	4.9	94	nw.	7.2	2,183	5.3	......	ne.	....
9:36 a. m.	5.4	94	nw.	5.8	2,574	2.0	......	ne.	....
10:21 a. m.	5.4	98	nw.	5.4	2,188	3.0	......	nne.	....
10:26 a. m.	5.6	98	nw.	5.4	1,988	1.4	......	nne.	....
10:41 a. m.	5.6	98	nw.	7.2	1,516	5.2	......	nne.	....
10:55 a. m.	5.4	98	nw.	6.3	1,021	8.7	......	n.	....
11:06 a. m.	5.6	98	nw.	6.3	794	8.9	......	nnw.	....
11:11 a. m.	5.6	98	n.	6.3	526	5.6	98	n.	6.3
October 30, 1908:									
2:55 p. m.	7.1	64	nw.	14.3	526	7.1	64	nw.	14.3
3:00 p. m.	7.1	59	nw.	13.0	961	2.5	......	nw.	....
3:11 p. m.	7.1	59	nw.	12.5	1,323	− 1.5	......	nw.	....
3:30 p. m.	7.3	58	nw.	12.1	1,919	− 6.7	......	nw.	....
3:52 p. m.	7.2	58	nw.	12.5	2,280	−11.5	......	nw.	....
4:01 p. m.	7.1	60	nw.	12.1	2,518	− 7.0	......	nw.	....
4:20 p. m.	6.9	61	nw.	11.6	3,103	− 8.5	......	nw.	....
4:40 p. m.	6.7	64	nw.	12.1	2,807	− 7.3	......	nw.	....
4:49 p. m.	6.7	64	nw.	12.1	2,177	−10.1	......	nw.	....
5:12 p. m.	6.7	53	nw.	12.5	1,751	− 7.9	......	nw.	....
5:24 p. m.	6.1	49	nw.	13.4	1,236	− 3.0	......	nw.	....
5:29 p. m.	6.1	49	nw.	13.4	1,018	− 1.0	......	nw.	....
5:37 p. m.	6.1	48	nw.	13.4	804	1.7	......	nw.	....
5:42 p. m.	5.8	45	nw.	13.0	526	5.8	45	nw.	13.0
October 31, 1908:									
6:59 a. m.	0.0	60	nw.	10.3	526	0.0	60	nw.	10.3
7:08 a. m.	0.0	60	nw.	9.8	847	− 1.8	......	wnw.	....
7:38 a. m.	0.4	58	nw.	9.4	1,393	− 6.1	......	nw.	....
7:46 a. m.	0.6	61	nw.	10.7	1,794	− 3.1	......	nw.	....
8:09 a. m.	1.3	55	nw.	13.0	2,114	− 3.0	......	wnw.	....
8:30 a. m.	2.0	58	nw.	13.0	2,591	− 6.2	......	wnw.	....
9:10 a. m.	3.7	52	nw.	13.4	3,369	−13.0	......	w.	....
9:45 a. m.	3.8	48	nw.	13.9	2,994	− 9.1	......	w.	....
10:03 a. m.	3.4	50	nw.	15.6	2,796	− 7.0	......	w.	....
10:20 a. m.	3.5	49	nw.	13.0	2,039	− 1.6	......	wnw.	....
10:35 a. m.	3.8	43	nw.	15.2	1,907	− 0.8	......	wnw.	....
10:46 a. m.	4.3	47	nw.	12.1	1,556	− 6.2	......	nw.	....
11:05 a. m.	4.0	48	nw.	13.0	1,198	− 3.3	......	wnw.	....
11:16 a. m.	4.3	46	nw.	12.5	886	− 0.4	......	wnw.	....
11:21 a. m.	4.4	46	nw.	13.4	526	4.4	46	nw.	13.4

October 29, 1908.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 5,486 m.; at maximum altitude, 4,877 m.

The sky was overcast during the flight. At first only A.-St. moving from the northeast were visible, but after 8 a. m. from 1/10 to 5/10 low St. were present moving from the north, and at 9:54 a. m. light rain began and continued to the end of the flight, accompanied with light fog.

An active low was central off the North Carolina coast and an extensive high over the upper Missouri Valley.

October 30, 1908.—Three kites were used; lifting surface, 14,5 sq. m. Wire out, 5,486 m.; at maximum altitude, 5,334 m.

From 3/10 to 8/10 St.-Cu. moving from the northwest were visible during flight.

A low was central over the Massachusetts coast and a high over Manitoba.

October 31, 1908.—Three kites were used; lifting surface, 19.4 sq. m. Wire out, 6,706 m., at maximum altitude.

St.-Cu. moving from the west-northwest appeared about 9 a. m., increased to 2/10 by 10 a. m., and decreased to a few by the end of the flight.

Marked low pressure was central over New Brunswick. High pressure, central north of Lake Superior, covered the United States, except New England.

RESULTS OF CAPTIVE BALLOON ASCENSION.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
November 2, 1908:	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
4:32 p. m.	8.1	49	sw.	2.7	526	8.1	49	sw.	2.7
4:40 p. m.	7.8	53	sw.	2.7	1,069	5.2	......	w.	....
5:05 p. m.	7.8	54	sw.	3.1	526	7.8	54	sw.	3.1

RESULTS OF KITE FLIGHTS.

Date and hour.	Air temperature.	Rel. hum.	Dir.	Velocity.	Height.	Air temperature.	Rel. hum.	Dir.	Velocity.
November 3, 1908:									
1:46 p. m.	13.8	42	s.	4.9	526	13.8	42	s.	4.9
1:59 p. m.	14.4	42	s.	4.5	743	12.0	......	ssw.	....
2:16 p. m.	13.9	44	s.	4.0	1,037	10.9	......	wsw.	....
2:22 p. m.	14.4	42	sw.	4.9	1,410	7.9	......	w.	....
2:46 p. m.	14.9	41	s.	4.9	1,977	3.4	......	wnw.	....
3:05 p. m.	14.4	43	s.	4.0	2,504	−2.6	......	wnw.	....
3:23 p. m.	13.9	46	s.	4.0	526	13.9	46	s.	4.0
November 4, 1908:									
7:12 a. m.	12.2	59	w.	8.9	526	12.2	59	w.	8.9
7:16 a. m.	12.2	59	w.	10.7	833	10.5	......	w.	....
7:25 a. m.	12.2	59	w.	10.7	1,283	6.8	......	w.	....
7:38 a. m.	12.2	59	w.	10.7	1,665	2.6	......	w.	....
7:52 a. m.	12.3	59	w.	10.7	1,970	−0.2	......	w.	....
8:05 a. m.	12.6	58	w.	10.7	2,488	−4.5	......	w.	....
8:33 a. m.	12.7	56	w.	10.7	2,844	−8.8	......	w.	....
8:58 a. m.	11.7	64	nw.	8.9	2,296	−6.1	......	w.	....
9:42 a. m.	12.1	56	nw.	11.6	1,696	0.1	......	w.	....
10:06 a. m.	11.9	56	nw.	10.7	1,239	4.1	......	w.	....
10:17 a. m.	11.9	56	nw.	8.0	863	7.4	......	w.	....
10:27 a. m.	11.9	56	nw.	8.0	526	11.9	56	nw.	8.0

November 2, 1908.—One balloon was used; capacity, 25.6 cu. m. Wire out, 1,494 m.

During the ascension light haze and 2/10 A.-Cu. moving from the northwest were present.

Pressure was high over Virginia and low over New Brunswick.

November 3, 1908.—Three kites were used; lifting surface, 19.4 sq. m. Wire out, 3,353 m., at maximum altitude.

Light haze prevailed during the flight. No clouds were observed.

Low pressure was central over Lake Superior and high pressure over western Virginia.

November 4, 1908.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 5,982 m., at the maximum altitude.

At the beginning 5/10 Ci. and 2/10 St.-Cu. moving from the west were present. The lower clouds increased rapidly. Rain began at 8:34, ended 9:39 a. m. At 9:40 a. m. the sky was entirely overcast with St. At the end of the flight 1/10 A.-St. and 7/10 St. were present.

Pressure was high over northern Minnesota and low over southwestern New Brunswick.

RESULTS OF KITE FLIGHTS.

	On Mount Weather, Va., 526 m.				At different heights above sea.				
	° C.	%		p. s.	Meters.	° C.	%		p. s.
November 5, 1908:									
7:23 a. m.	−5.6	75	nw.	13.0	526	−5.6	75	nw.	13.0
7:32 a. m.	−5.3	72	nw.	13.4	824	−8.4	......	nw.	......
7:45 a. m.	−4.9	70	nw.	15.2	1,036	−9.6	......	nw.	......
8:03 a. m.	−4.4	68	nw.	16.1	1,343	−9.0	......	nnw.	......
8:33 a. m.	−3.2	64	nw.	18.8	1,580	−11.2	......	nnw.	......
9:37 a. m.	−1.7	67	nw.	18.8	1,256	−7.8	......	nw.	......
9:45 a. m.	−1.6	65	nw.	16.1	1,065	−6.8	......	nw.	......
9:52 a. m.	−1.6	67	nw.	16.1	801	−5.4	......	nw.	......
10:01 a. m.	−1.3	62	nw.	17.9	526	−1.3	62	nw.	17.9
November 6, 1908:									
8:48 a. m.	1.1	33	sw.	3.1	526	1.1	33	sw.	3.1
8:49 a. m.	0.9	34	sw.	3.1	839	−2.1	......	w.	......
9:01 a. m.	1.4	30	sw.	3.6	1,270	−2.8	......	wnw.	......
9:29 a. m.	1.1	36	sw.	3.1	1,294	−0.2	......	wnw.	......
10:00 a. m.	3.8	32	sw.	4.5	1,613	1.8	......	wnw.	......
10:58 a. m.	4.4	35	sw.	4.5	1,854	−0.8	......	wnw.	......
11:13 a. m.	4.8	35	sw.	5.8	1,130	0.7	......	wnw.	......
11:31 a. m.	5.6	29	sw.	3.6	910	1.8	......	wsw.	......
11:36 a. m.	5.7	28	sw.	4.5	526	5.7	28	sw.	4.5
2d ascension:									
1:45 p. m.	10.0	24	sw.	6.3	526	10.0	24	sw.	6.8
1:55 p. m.	10.8	24	sw.	5.4	875	8.7	......	wsw.	......
2:09 p. m.	10.8	27	s.	4.5	1,294	6.9	......	w.	......
2:32 p. m.	10.9	27	sw.	6.7	2,146	2.3	......	w.	......
2:40 p. m.	10.9	27	sw.	6.7	526	10.9	27	sw.	6.7
November 7, 1908:									
7:20 a. m.	8.7	51	nw.	8.0	526	8.7	51	nw.	8.0
7:26 a. m.	8.4	64	nw.	7.6	846	5.9	......	nw.	......
7:40 a. m.	7.8	59	nw.	12.1	1,012	3.9	......	nw.	......
7:57 a. m.	7.4	61	nw.	10.7	1,312	2.0	......	w.	......
8:36 a. m.	7.5	62	nw.	12.5	1,677	0.0	......	wnw.	......
8:47 a. m.	7.8	60	nw.	14.8	1,910	4.7	......	wnw.	......
8:57 a. m.	8.0	66	nw.	16.1	2,210	5.3	......	wnw.	......
9:07 a. m.	8.2	55	nw.	16.5	2,288	5.0	......	wnw.	......
9:32 a. m.	8.2	58	nw.	16.2	1,862	6.2	......	wnw.	......
9:46 a. m.	8.2	58	nw.	18.4	1,649	1.5	......	wnw.	......
9:58 a. m.	8.3	54	nw.	10.7	1,346	2.0	......	w.	......
10:11 a. m.	8.8	54	nw.	10.7	1,002	3.3	......	wnw.	......
10:23 a. m.	8.6	51	nw.	10.7	780	4.7	......	nw.	......
10:32 a. m.	8.6	51	nw.	14.3	526	8.6	51	nw.	14.3

November 5, 1908.—Two kites were used; lifting surface, 9.1 sq. m. Wire out, 3,261 m., at maximum altitude.

The sky was from 1/10 to 4/10 covered with St.-Cu. moving from the northwest. From 8:25 a. m. to the end of the flight standing clouds were observed over both valleys, to the southeast and northwest. Light snow flurries fell from 9:35 to 9:40 a. m.

Pressure was high over Illinois and low over the Gulf of St. Lawrence.

November 6, 1908. First flight: Three kites were used; lifting surface, 19.4 sq. m. Wire out, 4,023 m.; at maximum altitude, 3,475 m.

From 7/10 to 4/10 A.-Cu. were visible until 9:30 a. m.; about 2/10 Ci-Cu. and A.-Cu. thereafter. All clouds were moving from the northwest.

Second flight: Two kites were used; lifting surface, 9.1 sq. m. Wire out, 2,957 m., at maximum altitude. A few Ci.-Cu. were visible near the eastern horizon.

Low pressure was central over the Gulf of St. Lawrence. Pressure was high over the Southern States.

November 7, 1908.—Three kites were used; lifting surface, 12.8 sq. m. Wire out, 3,658 m., at maximum altitude.

From 1/10 to 2/10 Ci. were visible moving from the west-northwest. Light haze prevailed during the flight.

A low was central over the Gulf of St. Lawrence and a high over the Texas coast.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
November 9, 1908:	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
7:15 a. m.	8.9	45	s.	8.0	526	8.9	45	s.	8.0
7:25 a. m.	9.2	45	s.	8.0	926	11.4	......	sw.	....
7:47 a. m.	9.4	46	s.	8.9	1,453	8.4	......	w.	....
8:08 a. m.	9.6	47	s.	8.9	1,880	6.6	......	w.	....
8:20 a. m.	10.0	44	s.	8.9	2,194	4.2	......	w.	....
9:14 a. m.	11.1	44	sw.	8.9	8,169	− 1.5	......	w.	....
10:06 a. m.	11.7	44	s.	8.0	8,829	− 6.8	......	w.	....
10:40 a. m.	11.8	44	sw.	8.0	3,164	− 2.2	......	wsw.	....
11:07 a. m.	12.8	44	s.	7.2	2,270	4.7	......	wsw.	....
11:28 a. m.	13.4	42	s.	5.4	1,477	10.8	......	w.	....
11:38 a. m.	13.9	44	s.	5.4	1,022	18.0	......	wsw.	....
11:50 a. m	18.9	41	s.	4.5	526	13.9	41	s.	4.5
November 10, 1908:									
1:22 p. m	13.0	57	s.	5.4	526	18.0	57	s.	5.4
1:31 p. m	18.2	57	s.	5.4	874	16.5	......	ssw.	....
1:50 p. m	13.8	61	s.	4.5	1,324	13.0	......	sw.	....
2:04 p. m	18.8	61	s.	4.5	1,680	9.1	......	sw.	....
2:18 p. m	12.8	65	s.	5.4	2,136	5.9	......	wsw.	....
2:40 p. m	13.6	62	sw.	6.7	2,740	1.8	......	wsw.	....
3:07 p. m	15.0	58	sw.	7.6	3,286	− 1.5	......	wsw.	....
4:10 p. m	15.6	58	sw.	6.7	2,628	0.9	......	wsw.	....
4:25 p. m	15.4	60	sw.	6.8	2,126	8.4	......	wsw.	....
4:38 p. m	13.9	64	nw.	5.4	1,712	6.7	......	wsw.	....
4:49 p. m	8.9	81	nw.	6.7	1,324	10.4	......	wsw.	....
4:59 p. m	8.9	81	nw.	8.0	832	14.2	......	wsw.	....
5:01 p. m	8.6	82	nw.	6.7	678	11.2	......	nw.	....
5:03 p. m	8.8	84	nw.	4.9	526	8.3	84	nw.	4.9
November 11, 1908:									
7:14 a. m	11.9	73	se.	3.1	526	11.9	73	se.	8.1
7:30 a. m	12.1	77	se.	3.1	872	18.5	......	sw.	....
8:10 a. m	12.8	75	sw.	1.4	1,319	7.7	......	sw.	....
8:21 a. m	12.2	79	sw.	8.1	1,702	5.9	......	wsw.	....
8:32 a. m	12.1	80	sw.	2.7	1,964	8.5	......	wsw.	....
9:58 a. m	11.7	82	sw.	2.2	2,299	2.0	......	wsw.	....
11:08 a. m	18.8	75	w.	8.1	2,873	− 0.4	......	wsw.	....
11:28 a. m	14.2	75	sw.	4.0	2,205	4.1	......	wsw.	....
11:40 a. m	14.3	75	sw.	4.0	1,857	6.1	.....	wsw.	....
11:50 a. m	14.4	73	w.	5.4	1,514	7.4	......	wsw.	....
12:00 noon	14.3	75	w.	5.4	1,185	10.2	......	wsw.	....
12:07 p. m	14.4	75	sw.	5.4	836	12.0	......	wsw.	....
12:10 p. m	14.5	72	sw.	5.4	526	14.5	72	sw.	5.4

November 9, 1908.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 6,020 m., at the maximum altitude.

Few Ci.-St. moving from the west, and a light haze were present during the flight.

Low pressure was central north of the upper Lakes. Pressure was relatively high over Florida.

November 10, 1908.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 5,944 m., at maximum altitude.

Light haze prevailed during the flight. From 7/10 to 2/10 Ci. were visible until 4:20 p. m. and 2/10 A.-Cu. thereafter.

High pressure was central over New England and low pressure over the Ohio Valley.

November 11, 1908.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 5,563 m.; at the maximum altitude, 4,572 m.

At the beginning 10/10 St. moving from the southwest, and light haze were present. Light rain began at 7:46 a. m. and ended at 9:48 a. m. 5/10 A.-St. and 5/10 St. were present at the end of the flight.

An extensive area of high pressure was central over Wyoming. Pressure was relatively low over the Middle Atlantic States.

RESULTS OF KITE FLIGHTS.

November 12, 1908:	° C.	%		p.s.	Meters.	° C.	%		p.s.
8:52 a. m.	-2.6	61	nw.	9.8	526	-2.6	61	nw.	9.8
9:02 a. m.	-1.9	56	nw.	11.2	904	-7.3	......	nw.	....
9:17 a. m.	-1.1	51	nw.	11.6	1,221	-10.6	......	nw.	....
9:26 a. m.	-1.5	61	nw.	12.5	1,503	-9.4	......	wnw.	....
10:10 a. m.	-1.7	56	nw.	11.6	1,816	-4.4	......	wnw.	....
10:59 a. m.	-0.6	53	nw.	14.8	2,792	-4.6	......	w.	....
11:28 a. m.	-0.1	47	nw.	14.8	3,492	-9.4	......	w.	....
11:55 a. m.	0.2	45	nw.	13.9	2,868	-6.4	......	w.	....
12:33 p. m.	0.5	52	nw.	13.4	2,176	-4.4	......	wnw.	....
1:19 p. m.	1.3	47	nw.	11.2	1,652	-10.4	......	wnw.	....
1:33 p. m.	1.7	35	nw.	10.7	1,202	-5.8	......	wnw.	....
1:44 p. m.	1.9	35	nw.	10.7	859	-2.4	......	wnw.	....
1:48 p. m.	2.2	42	nw.	10.7	526	2.2	42	nw.	10.7
November 13, 1908:									
7:22 a. m.	-3.9	60	nw.	10.3	526	-3.9	60	nw.	10.3
7:32 a. m.	-3.9	60	nw.	10.3	881	-7.3	......	wnw.	....
7:40 a. m.	-3.9	60	nw.	9.8	1,263	-10.5	......	wnw.	....
8:09 a. m.	-3.1	58	nw.	11.6	1,414	-9.0	......	wnw.	....
8:24 a. m.	-3.3	58	nw.	11.2	1,836	-6.0	......	wnw.	....
8:38 a. m.	-3.1	57	nw.	11.2	2,181	-6.0	......	wnw.	....
9:22 a. m.	-2.2	55	nw.	14.8	3,126	-11.1	......	nw.	....
10:20 a. m.	-1.5	42	nw.	9.8	2,318	-7.5	......	wnw.	....
10:40 a. m.	-1.1	47	nw.	8.5	1,926	-7.0	......	wnw.	....
10:58 a. m.	-0.7	40	nw.	9.4	1,318	-9.5	......	wnw.	....
11:10 a. m.	-0.6	39	nw.	9.8	849	-5.0	......	wnw.	....
11:19 a. m.	-0.4	39	nw.	9.4	526	-0.4	39	nw.	9.4
November 14, 1908:									
7:23 a. m.	-2.2	66	se.	3.6	526	-2.2	66	se.	3.6
7:40 a. m.	-2.6	65	se.	4.5	814	-5.8	......	sse.	....
7:54 a. m.	-3.1	64	se.	4.9	859	-3.3	......	sse.	....
8:09 a. m.	-3.8	73	se.	4.5	1,230	-5.0	......	sw.	....
8:20 a. m.	-3.8	100	se.	3.6	1,516	-2.1	......	sw.	....
8:36 a. m.	-3.9	100	se.	3.6	1,736	-3.0	......	sw.	....
9:28 a. m.	-3.9	100	se.	3.1	1,978	-1.2	......	sw.	....
9:48 a. m.	-3.9	100	se.	3.6	2,625	-3.7	......	sw.	....
10:04 a. m.	-3.9	100	se.	3.1	3,001	-4.5	......	sw.	....
10:27 a. m.	-3.8	100	se.	3.1	2,533	-2.4	......	sw.	....
10:51 a. m.	-3.4	100	se.	3.6	2,018	0.2	......	sw.	....
11:18 a. m.	-3.8	100	e.	3.1	1,715	0.3	......	sw.	....
11:26 a. m.	-3.8	100	se.	4.0	1,428	2.1	......	ssw.	....
11:40 a. m.	-3.8	100	se.	4.9	882	-3.6	......	s.	....
11:45 a. m.	-3.8	100	se.	3.6	526	-3.3	100	se.	3.6

November 12, 1908.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,791 m., at maximum altitude.

The sky was cloudless until 9 a. m., and from that time until the end of the flight a few St.-Cu. were visible moving from the west-northwest.

An extensive area of high pressure central over southern Saskatchewan overlay nearly the entire country. Pressure was low over New Brunswick.

November 13, 1908.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 5,791 m., at maximum altitude.

A few St. near the horizon were visible during the flight. A few Cu. from the west-northwest were visible after 9:22 a. m. A high was central over Wyoming and Montana, and a low over the Gulf of St. Lawrence.

November 14, 1908.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,791 m., at maximum altitude.

Snow began at 7 a. m.; clouds moving from the southwest. Dense fog set in at 8:45 a. m. The snow changed to sleet about 10:50 a. m. The head kite disappeared into the clouds at 8:25 a. m.

High pressure was central over eastern Maryland. Pressure was relatively low over the Gulf of St. Lawrence, Florida, and Lake Superior.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
November 16, 1908:	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
7:49 a. m.	−0.1	49	sw.	5.8	526	−0.1	49	sw.	5.8
8:12 a. m.	0.6	47	sw.	5.4	824	−1.6	......	wsw.	....
8:32 a. m.	1.0	44	sw.	5.4	1,271	−5.7	......	w.	....
8:56 a. m.	1.6	46	sw.	5.4	1,690	−5.7	......	w.	....
9:16 a. m.	1.7	46	sw.	5.8	2,070	−7.2	......	w.	....
9:42 a. m.	2.0	44	sw.	5.8	2,460	−10.2	......	w.	....
10:40 a. m.	2.8	41	sw.	6.8	3,042	−14.7	......	w.	....
11:30 a. m.	3.5	41	sw.	7.2	2,152	−9.6	......	w.	....
12:10 p. m.	3.9	41	sw.	7.2	1,696	−7.1	......	w.	....
12:21 p. m.	2.8	41	sw.	7.2	1,300	−4.1	......	w.	....
12:32 p. m.	3.1	45	sw.	6.7	893	−0.1	......	sw.	....
12:37 p. m.	3.1	45	s.	6.8	526	3.1	45	s.	6.8
November 17, 1908:									
9:06 a. m.	−3.9	57	nw.	13.4	526	−3.9	57	nw.	13.4
9:18 a. m.	−3.9	57	nw.	13.4	848	−7.1	......	w.	....
9:32 a. m.	−3.8	57	nw.	14.8	1,050	−9.1	......	w.	....
9:48 a. m.	−3.6	56	nw.	14.8	1,505	−8.1	......	w.	....
9:54 a. m.	−3.8	52	nw.	14.8	526	−3.3	52	nw.	14.8
November 18, 1908:									
8:26 a. m.	8.9	45	w.	7.6	526	8.9	45	w.	7.6
8:39 a. m.	8.9	47	w.	8.0	898	6.5	......	wnw.	....
8:58 a. m.	8.9	48	w.	7.6	1,469	2.0	......	wnw.	....
9:39 a. m.	9.5	49	w.	9.4	1,613	1.0	......	wnw.	....
10:02 a. m.	10.0	44	w.	11.2	2,241	−1.8	......	wnw.	....
10:40 a. m.	10.4	44	w.	10.7	1,890	−0.5	......	wnw.	....
11:00 a. m.	10.8	44	nw.	13.9	1,719	−0.5	......	wnw.	....
11:21 a. m.	11.4	39	nw.	14.3	1,444	−0.5	......	wnw.	....
11:51 a. m.	11.1	41	nw.	21.0	837	7.9	......	wnw.	....
11:55 a. m.	11.4	41	nw.	21.0	526	11.4	41	nw.	21.0

November 16, 1908.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 5,791 m., at maximum altitude.

The sky was cloudless at the beginning. After 8:50 a. m. a few A.-St. were visible near the southern horizon, and a few isolated patches were forming and disappearing over Loudoun Valley.

High pressure was central over western Colorado, and pressure was low over Quebec and Ontario.

November 17, 1908—Two kites were used; lifting surface, 10.8 sq. m. Wire out, 2,365 m., at maximum altitude.

The sky was cloudless.

High pressure was central off the Texas coast; low pressure over New Brunswick.

November 18, 1908.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 5,486 m., at maximum altitude.

From 3/10 to a few A.-St. moving from the west-northwest were visible until 10 a. m. During the remainder of the flight the sky was cloudless.

A low was central over Lake Ontario and a high over the Gulf of Mexico.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air temperature.	Rel. hum.	Wind. Dir.	Wind. Velocity.
November 19, 1908:	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
7:20 a. m.	1.6	84	sw.	7.6	526	1.6	84	sw.	7.6
7:28 a. m.	1.6	84	sw.	7.6	877	7.0	......	wsw.	....
7:54 a. m.	2.1	82	s.	6.7	1,498	7.0	......	w.	....
8:20 a. m.	3.1	75	s.	7.6	1,757	8.0	......	w.	....
8:45 a. m.	5.0	65	sw.	5.8	2,132	7.0	......	wnw.	....
9:50 a. m.	6.4	68	s.	3.6	2,950	1.3	......	wnw.	....
10:40 a. m.	6.9	64	se.	4.0	3,924	− 3.5	......	wnw.	....
11:17 a. m.	7.9	61	se.	4.0	2,960	2.4	......	wnw.	....
11:33 a. m.	8.9	57	se.	4.0	2,489	5.4	......	w.	....
11:49 a. m.	8.9	57	s.	4.5	1,968	7.2	......	w.	....
12:05 p. m.	8.9	57	s.	5.8	1,298	11.2	......	w.	....
12:18 p. m.	9.6	52	s.	4.9	908	12.8	......	wsw.	....
12:20 p. m.	9.7	52	s.	4.9	815	12.4	......	sw.	....
12:22 p. m.	9.4	51	s.	4.9	526	9.4	51	s.	4.9
November 20, 1908:									
7:23 a. m.	11.1	52	nw.	4.9	526	11.1	52	nw.	4.9
7:33 a. m.	11.4	50	nw.	4.9	857	9.9	......	nnw.	....
7:54 a. m.	11.1	52	nw.	5.8	1,029	8.0	......	nnw.	....
8:18 a. m.	10.1	55	nw.	9.4	1,082	9.2	......	nw.	....
8:44 a. m.	9.4	61	n.	9.8	965	12.1	......	wnw.	....
9:18 a. m.	8.0	68	n.	9.8	1,683	4.1	......	nw.	....
9:42 a. m.	8.2	69	nw.	8.9	2,199	0.1	......	nw.	....
9:55 a. m.	8.1	70	nw.	8.9	2,750	− 4.0	......	nw.	....
10:56 a. m.	8.9	72	nw.	9.8	3,042	− 6.5	......	nw.	....
11:11 a. m.	8.9	72	nw.	9.8	3,839	−11.4	......	nw.	....
11:40 a. m.	9.4	68	nw.	9.8	3,346	− 8.0	......	nw.	....
11:58 a. m.	9.4	67	nw.	9.8	2,454	− 0.9	......	nw.	....
12:10 p. m.	9.4	66	nw.	10.3	1,646	5.6	......	nw.	....
12:20 p. m.	9.8	64	nw.	10.7	1,372	8.0	......	nw.	....
12:35 p. m.	9.8	61	nw.	9.8	882	8.9	......	nw.	....
12:40 p. m.	9.7	58	nw.	8.9	526	9.7	58	nw.	8.9
November 21, 1908:									
2:31 p. m.	6.2	60	se.	4.9	526	6.2	60	se.	4.9
2:37 p. m.	6.4	59	se.	5.4	711	3.1	......	s.	....
2:58 p. m.	6.8	54	se.	5.8	877	8.5	......	ssw.	....
4:08 p. m.	5.6	55	se.	5.8	1,386	7.0	......	ssw.	....
4:12 p. m.	5.3	58	se.	5.4	1,141	6.8	......	s.	....
4:20 p. m.	5.2	59	se.	4.5	526	5.2	59	se.	4.5

November 19, 1908.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,944 m.; at maximum altitude, 5,791 m.

At 7 a. m. haze lay in low banks over both valleys, and by 10 a. m. light haze surrounded the station. From a few to 3/10 Ci. were observed moving from the west-northwest.

Pressure was high over North Carolina and low north of Lake Huron.

November 20, 1908.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 5,944 m., at maximum altitude.

Ci.-Cu. and A.-Cu. moving from the southwest and St.-Cu. from the northwest were visible in amounts decreasing from 9/10 at the beginning to few after 10 a. m. Haze, present thruout the flight, obscured the kites from 9:45 until 11:05 a. m.

Pressure was high over the Lakes and the Gulf States and was relatively low off the Rhode Island coast.

November 21, 1908.—Three kites were used; lifting surface, 19.4 sq. m. Wire out, 1,829 m.; at maximum altitude, 1,500 m.

The sky was cloudless. Light haze prevailed during the flight.

A high was central over the north Atlantic coast and a low over Saskatchewan.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
November 23, 1908:									
7:51 a. m	8.8	87	sw.	2.7	526	8.8	87	sw.	2.7
8:03 a. m	9.0	86	sw.	3.1	922	8.8	......	ssw.	....
8:45 a. m	9.6	80	sw.	2.7	1,266	8.2	......	sw.	....
10:22 a. m	11.0	75	s.	4.5	1,770	5.3	......	ssw.	....
11:44 a. m	11.1	75	s.	4.5	2,125	4.8	......	ssw.	....
11:57 a. m	11.9	74	s.	3.6	1,917	4.4	......	sw.	....
12:04 p. m	12.0	70	s.	3.6	1,635	5.7	......	sw.	....
12:15 p. m	11.9	70	s.	3.6	1,185	7.8	......	ssw.	....
12:24 p. m	11.2	76	s.	3.6	865	9.6	......	ssw.	....
12:31 p. m	12.4	70	se.	3.6	526	12.4	70	se.	3.6
November 24, 1908:									
7:25 a. m	9.1	100	s.	3.6	526	9.1	100	s.	3.6
7:30 a. m	8.5	100	s.	3.6	837	9.4	......	s.	....
7:44 a. m	7.8	100	s.	3.6	1,154	8.5	......	ssw.	....
7:58 a. m	10.0	99	s.	5.8	1,430	7.5	......	sw.	....
8:28 a. m	8.8	100	s.	5.4	1,635	9.7	......	sw.	....
9:31 a. m	9.2	96	s.	2.7	2,130	5.6	......	sw.	....
10:19 a. m	9.4	99	se.	2.7	2,533	2.5	......	sw.	....
10:36 a. m	8.4	100	se.	3.6	2,016	4.6	......	sw.	....
10:46 a. m	8.0	100	s.	4.0	1,764	7.5	......	sw.	....
10:53 a. m	8.8	100	s.	4.0	1,678	6.3	......	sw.	....
11:06 a. m	8.8	100	s.	4.0	1,080	9.3	......	ssw.	....
11:17 a. m	9.3	100	s.	4.0	837	11.4	......	s.	....
11:24 a. m	9.8	100	s.	4.0	526	9.8	100	s.	4.0
November 25, 1908:									
1:18 p. m	11.8	100	se.	4.9	526	11.8	100	se.	4.9
1:30 p. m	11.4	100	se.	5.4	834	11.6	......	s.	....
1:53 p. m	11.4	100	se.	5.4	1,285	14.0	......	s.	....
2:35 p. m	11.6	100	se.	7.2	1,934	11.6	......	s.	....
3:28 p. m	11.6	100	se.	6.3	2,798	3.6	......	s.	....
3:50 p. m	11.4	100	se.	6.3	1,749	11.9	......	s.	....
4:00 p. m	11.4	100	se.	6.3	1,262	14.2	......	s.	....
4:10 p. m	11.4	100	se.	6.3	884	12.0	......	s.	....
4:15 p. m	11.4	100	se.	6.3	526	11.4	100	se.	6.3

November 23, 1908.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,944 m.; at maximum altitude, 3,048 m.

At the beginning 7/10 Ci.-Cu. moving from the southwest were present. These had diminished to 2/10 at the end of the flight.

Pressure was high over the north Atlantic coast and low pressure was central over southwestern Kansas.

November 24, 1908.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 5,029 m.; at maximum altitude, 3,650 m.

Fog, dense at intervals, prevailed during the flight. From 1/10 to 3/10 Ci. moving from the west were occasionally visible.

A low was central over Iowa and a high off the North Carolina coast.

November 25, 1908.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 4,115 m.; at maximum altitude, 3,505 m.

Dense fog prevailed thruout the flight.

Pressure was high over New Brunswick and low over Kansas.

RESULTS OF KITE FLIGHTS.

	On Mount Weather, Va., 526 m.				At different heights above sea.				
November 26, 1908:	° C.	%		p. s.	Meters.	° C.	%		p. s.
7:20 a. m.	10.7	100	s.	4.0	526	10.7	100	s.	4.0
7:32 a. m.	10.9	100	s.	4.5	992	15.0	......	sw.	......
7:37 a. m.	10.9	100	s.	5.8	1,194	16.2	......	sw.	......
7:57 a. m.	11.0	100	s.	6.8	1,688	18.2	......	sw.	......
8:22 a. m.	11.0	100	s.	5.4	2,182	7.9	......	sw.	......
8:39 a. m.	11.0	100	s.	5.8	2,460	5.2	......	sw.	......
9:00 a. m.	11.1	100	s.	6.4	2,961	4.4	......	sw.	......
9:16 a. m.	11.2	100	s.	[illegible]	3,800	2.3	......	sw.	......
9:39 a. m.	11.3	100	s.	5.4	2,869	3.1	......	sw.	......
10:05 a. m.	11.4	100	s.	6.3	2,157	9.5	......	sw.	......
10:25 a. m.	11.7	100	s.	7.2	1,820	18.2	......	sw.	......
10:37 a. m.	11.8	100	s.	7.2	1,371	16.5	......	sw.	......
10:49 a. m.	11.9	100	s.	6.7	967	17.7	......	sw.	......
10:54 a. m.	11.9	100	s.	6.7	526	11.9	100	[illegible]	6.7
November 27, 1908:									
7:23 a. m.	6.3	52	nw.	10.7	[illegible]	6.3	52	nw.	10.7
7:30 a. m.	6.3	52	nw.	9.8	800	3.5	......	w.	......
7:49 a. m.	6.4	51	nw.	9.8	1,327	0.0	......	w.	......
8:48 a. m.	7.2	48	nw.	8.0	1,681	6.8	......	w.	......
9:15 a. m.	8.2	47	nw.	7.6	1,486	8.4	......	w.	......
10:07 a. m.	9.2	42	nw.	8.0	1,488	1.8	......	w.	......
10:50 a. m.	10.8	40	nw.	9.4	871	5.6	......	w.	......
11:01 a. m.	10.7	38	nw.	9.8	526	10.7	38	nw.	9.8
November 28, 1908:									
7:27 a. m	0.4	74	nw.	12.5	526	0.4	74	nw.	12.5
7:40 a. m	0.5	74	nw.	11.6	825	3.1	......	nw.	......
7:45 a. m	0.6	74	nw.	12.5	897	6.6	......	nw.	......
7:56 a. m	0.6	74	nw.	[illegible]	1,164	5.6	......	nw.	......
8:54 a. m	0.7	75	nw.	6.5	1,391	5.1	......	nw.	......
9:40 a. m	1.5	73	nw.	8.0	975	5.1	......	nw.	......
9:50 a. m	1.6	73	nw.	6.0	808	6.7	......	nw.	......
10:36 a. m	2.8	66	nw.	7.6	526	2.8	66	nw.	7.6

November 26, 1908.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 5,944 m.; at maximum altitude, 5,639 m.

Dense fog prevailed thruout the flight.

Low pressure was central north of Lake Superior.

November 27, 1908.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 5,486 m.; at maximum altitude, 3,962 m.

A few A.-St. were visible moving from the west.

A high was central over Missouri and Illinois and a low over the Gulf of St. Lawrence.

November 28, 1908.—Six kites were used; lifting surface, 32.5 sq. m. Wire out, 4,877 m.; at maximum altitude, 2,250 m.

The sky was nearly covered with large A.-Cu. until about 8:30 a. m. and with A.-St. thereafter. All clouds were moving from the west.

High pressure covered the eastern United States.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
November 30, 1908:									
8:07 a. m	11.6	88	sw.	8.0	526	11.6	88	sw.	8.0
8:17 a. m	12.4	88	sw.	7.2	911	14.1	......	sw.	....
8:30 a. m	15.0	74	sw.	7.6	1,363	10.7	......	sw.	....
9:15 a. m	12.4	79	sw.	7.2	2,144	10.2	......	sw.	....
10:00 a. m	15.3	70	sw.	5.4	2,719	7.4	......	sw.	....
10:52 a. m	15.0	68	sw.	6.8	3,164	3.5	......	wsw.	....
11:25 a. m	16.4	59	sw.	6.8	2,274	7.3	......	wsw.	....
11:50 a. m	15.4	68	sw.	5.4	1,580	11.8	......	sw.	....
12:01 p. m	14.8	68	sw.	8.6	1,270	10.8	......	sw.	....
12:10 p. m	14.8	70	s.	8.1	959	13.2	......	sw.	....
12:14 p. m	14.5	73	s.	8.1	526	14.5	73	s.	8.1
December 1, 1908:									
7:25 a. m.	13.9	57	nw.	7.6	526	13.9	57	nw.	7.6
7:34 a. m.	13.8	55	nw.	8.5	906	10.9	......	wnw.	....
7:56 a. m.	12.2	56	nw.	6.8	1,428	6.6	......	w.	....
8:29 a. m.	13.2	52	w.	6.7	1,890	2.5	......	w.	....
9:00 a. m.	13.6	48	nw.	6.8	2,459	2.6	......	w.	....
9:50 a. m.	13.8	47	w.	6.7	2,869	2.7	......	w.	....
10:10 a. m.	14.8	43	w.	6.7	2,468	5.1	......	w.	....
10:50 a. m.	15.4	44	w.	9.8	1,984	7.0	......	w.	....
11:15 a. m.	15.1	45	w.	8.9	1,974	0.0	......	wnw.	....
11:37 a. m.	14.9	44	nw.	7.6	1,609	1.9	......	wnw.	....
11:51 a. m.	14.8	43	nw.	9.8	1,211	6.0	......	wnw.	....
12:01 p. m.	14.5	42	nw.	10.7	841	10.0	......	wnw.	....
12:09 p. m.	14.9	42	nw.	10.3	526	14.9	42	nw.	10.3
December 2, 1908:									
1:20 p. m.	−4.3	37	nw.	13.9	526	−4.3	37	nw.	13.9
1:30 p. m.	−4.0	44	nw.	13.4	842	−9.0	......	wnw.	....
2:19 p. m.	−3.9	38	nw.	13.0	1,472	−13.5	......	nw.	....
2:48 p. m.	−3.5	39	nw.	10.3	2,036	−11.5	......	nw.	....
2:53 p. m.	−3.5	39	nw.	10.3	2,294	−10.0	.....	nw.	....
3:18 p. m.	−3.7	46	nw.	9.8	3,145	−12.7	......	nw.	....
3:33 p. m.	−3.9	38	nw.	8.9	2,734	−10.5	......	nw.	....
3:58 p. m.	−3.9	35	nw.	7.6	2,202	−13.6	......	nw.	....
4:27 p. m.	−4.4	36	nw.	9.4	1,669	−16.0	......	wnw.	....
4:40 p. m.	−4.6	37	nw.	8.9	1,154	−12.2	.....	wnw.	....
4:52 p. m.	−5.0	42	nw.	8.8	859	−9.1	......	wnw.	....
4:58 p. m.	−5.0	43	nw.	8.9	526	−5.0	43	nw.	8.9

November 30, 1908.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 6,096 m., at maximum altitude.

The sky was overcast with A.-St. moving from the west at the beginning of the flight. The clouds gradually became thinner and at the end of the flight 5/10 Ci. and 3/10 A.-St. were present.

An extensive area of low pressure was central over Wisconsin. Pressure was relatively high along the Atlantic coast.

December 1, 1908.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 6,066 m.; at maximum altitude, 5,734 m.

Low A.-Cu. nearly covered the sky until 8:15 a. m. when Ci.-St. appeared. Cloudiness had decreased to 4/10 by 10 a. m. After 10:45 a. m. Ci.-St., Ci.-Cu., and St.-Cu. moving from the northwest, covered about 8/10 of the sky. Clouds moved from the west, except where noted.

Pressure was low north and east of the Lakes. The remainder of the country was covered by an extensive area of very high pressure central over northeastern Wyoming.

December 2, 1908.—Three kites were used; lifting surface, 16.2 sq. m. Wire out, 5,800 m.; at maximum altitude, 5,500 m.

The sky was cloudless.

An extensive area of high pressure was central over Missouri and Kansas. A low was central over the Gulf of St. Lawrence.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
December 3, 1908:									
9:37 a.m.	− 7.3	52	nw.	13.4	526	− 7.3	52	nw.	13.4
9:54 a.m.	− 7.2	54	nw.	12.1	869	−12.0	......	nw.	....
10:03 a.m.	− 7.1	54	nw.	10.3	1,026	− 9.8	......	nw.	....
10:16 a.m.	− 6.9	54	nw.	11.6	1,420	− 5.6	......	nw.	....
11:01 a.m.	− 6.0	44	nw.	10.3	1,854	− 5.5	......	nw.	....
11:50 a.m.	− 5.0	48	nw.	6.7	1,523	− 4.3	......	nw.	....
12:02 p.m.	− 4.8	34	nw.	6.7	1,009	− 5.2	......	nw.	....
12:06 p.m.	− 5.0	34	nw.	6.7	889	− 7.5	......	wnw.	....
12:09 p.m.	− 4.7	38	nw.	6.7	526	− 4.7	38	nw.	6.7
December 4, 1908:									
7:17 a.m.	− 4.3	47	sw.	10.3	526	− 4.3	47	sw.	10.3
7:25 a.m.	− 4.3	47	sw.	9.8	1,007	1.9	......	sw.	....
8:04 a.m.	− 4.5	51	s.	5.8	1,870	0.0	......	sw.	....
8:25 a.m.	− 5.2	57	s.	6.3	1,816	− 0.8	......	sw.	....
8:44 a.m.	− 5.2	63	s.	6.3	2,358	− 4.5	......	sw.	....
8:55 a.m.	− 4.8	58	s.	8.0	2,930	− 1.3	......	sw.	....
9:32 a.m.	− 3.6	50	sw.	6.3	3,602	− 6.0	......	wsw.	....
10:02 a.m.	− 3.2	52	se.	4.0	3,026	− 0.6	......	sw.	....
10:33 a.m.	− 2.8	53	se.	7.6	2,754	− 1.8	......	wsw.	....
10:43 a.m.	− 2.8	48	s.	5.8	2,243	− 3.5	......	sw.	....
10:53 a.m.	− 2.6	50	s.	8.0	1,859	− 1.0	......	sw.	....
11:08 a.m.	− 2.2	54	s.	4.5	1,378	2.9	......	sw.	....
11:18 a.m.	− 1.6	54	s.	4.0	981	0.3	......	sw.	....
11:23 a.m.	− 1.7	45	s.	4.0	526	− 1.7	45	s.	4.0
December 5, 1908:									
7:25 a.m.	0.9	85	nw.	4.9	526	0.9	85	nw.	4.9
7:34 a.m.	0.9	85	nw.	5.4	992	− 1.5	......	nw.	....
7:45 a.m.	0.9	85	nw.	5.4	1,215	− 3.8	......	nw.	....
9:07 a.m.	0.6	90	nw.	3.1	1,360	− 5.6	......	nw.	....
9:28 a.m.	0.4	92	n.	3.1	772	− 2.9	......	nw.	....
9:39 a.m.	0.3	95	n.	3.1	526	0.3	95	n.	3.1
2d flight.									
1:11 p.m.	1.1	81	nw.	6.3	526	1.1	81	nw.	6.3
1:27 p.m.	1.0	81	nw.	4.0	967	− 2.5	......	nw.	....
2:13 p.m.	0.9	78	nw.	7.6	1,470	− 6.2	......	nw.	....
2:30 p.m.	0.9	76	nw.	7.6	781	− 2.0	......	nw.	....
2:34 p.m.	1.0	77	nw.	7.6	526	1.0	77	nw.	7.6

December 3, 1908.—Four kites were used; lifting surface, 23.4 sq. m. Wire out, 3,000 m., at maximum altitude.

Light haze prevailed. A few Ci. were present moving from the west-northwest. Pressure was high over West Virginia and low over South Dakota and Lake Superior.

December 4, 1908.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 6,096 m., at maximum altitude.

The sky was overcast with Ci.-St. and A.-St. moving from the west. A solar halo was visible from 9:40 to 9:50 a. m. A few A.-Cu. obscured the head kite from 10:06 to 10:10 a. m. at an altitude of about 2,900 m.

A low was over Lake Huron, with a secondary depression over Arkansas. Pressure was high along the Atlantic coast.

December 5, 1908.—During the first flight three kites were used; lifting surface, 18.9 sq. m. Wire out, 3,000 m.; at maximum altitude, 2,600 m.

About 10/10 St. moving from the northwest at a height of 1,000 m. were visible until 8:28 a. m., and 10/10 Nb. thereafter. Light snow fell after 8:28 a. m.

In the second flight two kites were used; lifting surfaee, 12.6 sq. m. Wire out, 1,323.

From 10/10 to 3/10 St. were visible moving from the west-northwest.

At 8 a. m. a high was central over Illinois, and a low over New Brunswick.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
December 7, 1908:	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
9:22 a. m.	1.4	100	nw.	10.7	526	1.4	100	nw.	10.7
9:34 a. m.	2.4	100	nw.	10.7	807	3.6	......	wnw.	....
9:47 a. m	3.7	100	nw.	9.8	1,124	3.0	......	wnw.	....
10:15 a. m.	3.1	100	nw.	10.8	1,596	1.5	......	w.	....
10:47 a. m	3.7	100	nw.	9.8	2,000	− 1.3	......	w.	....
11:28 a. m.	3.8	100	nw.	9.8	3,012	− 6.2	......	sw.	....
11:58 a. m.	3.8	97	nw.	20.6	2,857	− 2.4	......	wsw.	....
12:20 p. m	4.0	84	nw.	20.6	1,745	3.4	......	w.	....
12:38 p. m	4.2	72	nw.	17.9	1,824	3.4	......	wnw.	....
12:50 p. m	4.3	68	nw.	18.8	1,086	0.1	......	wnw.	....
1:09 p. m	4.0	66	nw.	18.4	777	1.8	......	wnw.	....
1:13 p. m	4.1	65	nw.	12.5	526	4.1	65	nw.	12.5
December 8, 1908:									
7:41 a. m.	−6.7	70	nw.	10.7	526	− 6.7	70	nw.	10.7
7:56 a. m	−6.7	70	nw.	9.4	897	−10.4	......	nw.	....
8:27 a. m.	−6.8	70	nw.	9.4	1,513	− 5.2	......	nw.	....
8:52 a. m	−6.1	70	nw.	9.4	1,762	− 2.5	......	wnw.	....
9:15 a. m.	−5.9	63	nw.	12.1	2,789	− 9.0	......	w.	....
10:17 a. m.	−5.0	57	nw.	10.7	3,415	−14.6	......	w.	....
10:58 a. m.	−4.8	57	nw.	8.9	2,630	− 8.4	......	w.	....
11:24 a. m.	−3.9	54	nw.	7.2	1,793	− 3.6	......	wnw.	....
11:38 a. m	−3.3	52	nw.	6.3	1,375	− 5.9	......	nw.	....
11:44 a. m.	−3.8	52	nw.	7.2	908	− 9.6	......	nw.	....
11:51 a. m.	−2.8	53	nw.	7.2	526	− 2.8	53	nw.	7.2
December 9, 1908:									
7:25 a. m.	−2.1	66	sw.	4.5	526	− 2.1	66	sw.	4.5
7:41 a. m	−1.9	58	sw.	5.4	914	− 4.8	......	wsw.	....
8:00 a. m.	−1.7	56	sw.	6.3	1,287	− 8.7	......	w.	....
8:20 a. m	−1.3	60	sw.	6.3	1,684	−12.4	......	wnw.	....
8:40 a. m	−1.1	60	sw.	5.8	1,844	− 9.9	......	wnw.	....
9:14 a. m.	−0.1	50	sw.	6.3	2,698	−13.8	......	wnw.	....
10:09 a. m	−0.4	58	w.	6.3	2,167	− 11.7	......	wnw.	....
10:30 a. m.	−0.7	68	w.	5.8	1,821	−12.4	......	wnw.	....
10:40 a. m	−0.6	69	nw.	4.9	1,553	−11.7	......	wnw.	....
10:48 a. m.	−0.6	69	w.	4.9	1,218	− 9.3	......	wnw.	....
10:55 a. m.	−0.6	69	w.	4.9	777	− 5.8	......	w.	....
10:59 a. m.	−0.2	66	w.	4.5	526	− 0.2	66	w.	4.5

December 7, 1908.—Three kites were used; lifting surface, 16.2 sq. m. Wire out, 6,000 m., at maximum altitude.

Light rain and dense fog prevailed at the beginning. The rain ended at 9:44 a. m. and the fog lifted at 11:40 a. m. 3/10 A.-St. and 5/10 S.-Cu. moving from the southwest were present after 11:40 a. m. The sky was clearing in the northwest. The S.-Cu. were not reached by the kites.

Low pressure was central over Lake Huron. Pressure was high over the Gulf of St. Lawrence and eastern Kansas.

December 8, 1908.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 6,000 m.; at maximum altitude, 5,500 m.

A few Ci.-St. were visible near the horizon.

A high was central over the lower Mississippi Valley, and a low over the Gulf of St. Lawrence.

December 9, 1908.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 6,000 m., at maximum altitude.

At the beginning 10/10 St. moving from the west-northwest were present. These began to disappear rapidly at 8:40 a. m. and at 9:10 a. m. the sky was almost clear. A thin sheet of high clouds formed, producing a solar halo which lasted from 9:14 to 9:20 a. m. The clouds lowered rapidly and snow began at 9:42 a. m. and continued during the remainder of the flight. The base of the clouds from which the snow was falling was about 1,200 m. above sea level.

High pressure was central over Mississippi, and was relatively low over Vermont.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
December 10, 1908:	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
7:15 a. m.	-6.8	68	n.	4.0	526	-6.8	68	n.	4.0
7:22 a. m.	-6.9	68	n.	3.6	651	-7.2	......	nnw.	....
7:48 a. m.	-6.3	66	nw.	3.6	898	-9.5	......	nnw.	....
8:16 a. m.	-5.8	59	nw.	2.7	701	-7.2	......	nnw.	....
8:37 a. m.	-5.0	57	nw.	2.7	526	-5.0	57	nw.	2.7
December 11, 1908:									
7:30 a. m.	-3.3	85	s.	5.4	526	-3.3	85	s.	5.4
7:40 a. m.	-3.1	83	s.	5.4	984	5.2	......	wsw.	....
7:59 a. m.	-3.1	85	s.	5.4	1,227	4.9	......	wsw.	....
8:26 a. m.	-2.2	80	sw.	7.2	2,120	-1.5	......	wsw.	....
8:37 a. m.	-1.7	78	sw.	5.4	2,556	-1.9	......	wsw.	....
8:40 a. m.	-1.7	78	sw.	5.4	526	-1.7	78	sw.	5.4
December 12, 1908:									
8:31 a. m.	-0.2	79	nw.	17.4	526	-0.2	79	nw.	17.4
8:40 a. m.	-0.4	81	nw.	17.9	1,019	-3.9	......	nw.	....
9:05 a. m.	-0.6	79	nw.	13.9	1,247	-7.7	......	wnw.	....
9:29 a. m.	-0.4	76	nw.	14.8	1,705	-11.5	......	wnw.	....
9:40 a. m.	-0.2	69	nw.	18.8	2,211	-7.2	......	wnw.	....
10:09 a. m.	0.0	69	nw.	19.7	1,964	-8.7	......	nw.	....
10:37 a. m.	-0.6	63	nw.	19.7	1,611	-5.7	......	nw.	....
10:59 a. m.	-0.9	64	nw.	14.3	1,297	-8.5	......	wnw.	....
11:15 a. m.	-0.4	58	nw.	13.9	826	-4.0	......	wnw.	....
11:23 a. m.	-0.3	59	nw.	13.9	526	-0.3	59	nw.	13.9

December 10, 1908.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 1,000 m.; at maximum altitude, 800 m.

A few St.-Cu. were observed near the western horizon at the beginning of the flight; at 7:40 a. m. a few Ci. appeared moving from the northwest.

An area of high pressure central over northern New York overlay States east of the Mississippi River. Pressure was low over Manitoba and Kansas.

December 11, 1908.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 3,000 m., at maximum altitude.

The sky was covered with St. moving from the west-southwest until 8:30 a. m. and with Nb. thereafter. Heavy snow began at 8:30 a. m. and continued until the end of the flight. Just before the snow began an unusually heavy electric discharge was observed, when the earth connection at the reel was broken.

A low was central over the upper Lakes. High pressure prevailed along the Atlantic coast.

December 12, 1908.—Two kites were used; lifting surface, 10.8 sq. m. Wire out, 5,000 m., at maximum altitude.

St.-Cu. moving from the west-northwest, with a lower layer from the northwest, nearly covered the sky until 9:15 a. m. By 9:45 a. m. only 3/10 St.-Cu. moving from the west-northwest were visible. Ci.-Cu. moving from the west appeared about 10 a. m. At the end 1/10 each Ci.-Cu. and St.-Cu. were present. The head kite entered the St.-Cu. at 8:43 a. m. at about 1,170 m. The clouds cleared away from the kites at 9:55 a. m. The last 500 m. of wire was covered with frost.

Low pressure was central over Nantucket. Pressure was relatively high over Mississippi.

RESULTS OF KITE FLIGHTS.

						t heights above sea.			
							Rel. hum.	Wind. Dir.	Wind. Velocity.
December 14, 1908:	° C.			Meters p. s.	Meters.	° C.	%		Meters p. s.
7:41 a. m.	0.1	53	sw.	4.6	526	0.1	53	sw.	4.5
9:40 a. m.	1.1	51	w.	4.5	922	− 2.8		w.	
9:50 a. m.	1.1	50	w.	4.5	1,403	− 4.1		wnw.	
9:55 a. m.	1.1	49	w.	4.5	1,577	− 2.5		wnw.	
10:01 a. m.	1.1	49	w.	5.4	1,878	− 3.6		wnw.	
10:35 a. m.	1.4	49	w.	4.5	2,294	− 4.2		nw.	
12:20 p. m.	4.6	37	w.	5.4	1,846	− 0.5		wnw.	
12:26 p. m.	4.5	36	w.	5.4	1,589	− 0.1		w.	
12:29 p. m.	4.7	35	w.	5.4	1,290	− 1.1		w.	
12:42 p. m.	5.0	34	w.	4.9	716	2.8		wsw.	
12:44 p. m.	5.0	35	sw.	4.9	526	5.0	35	sw.	4.9
December 15, 1908:									
7:18 a. m.	7.2	36	w.	9.4	526	7.2	36	w.	9.4
7:24 a. m.	7.2	36	w.	9.4	928	5.2		wnw.	
7:37 a. m.	7.1	38	w.	8.9	1,250	6.0		wnw.	
8:15 a. m.	7.9	37	w.	9.4	1,672	4.2		w.	
9:04 a. m.	8.6	36	w.	10.8	2,089	2.6		w.	
9:25 a. m.	8.9	36	w.	9.4	2,769	− 4.4		w.	
10:05 a. m.	9.4	37	w.	8.9	3,268	− 8.5		w.	
10:30 a. m.	8.9	38	w.	9.8	2,654	− 4.0		w.	
10:42 a. m.	8.7	38	w.	8.5	2,244	− 0.6		w.	
10:47 a. m.	8.8	39	w.	8.5	2,156	− 1.5		w.	
10:57 a. m.	8.8	37	w.	8.9	1,581	3.8		w.	
11:26 a. m.	10.0	35	w.	9.4	939	7.7		w.	
11:31 a. m.	10.0	35	w.	8.9	526	10.0	35	w.	8.9
December 16, 1908:									
7:22 a. m.	4.6	74	nw	8.5	526	4.6	74	nw.	8.5
7:30 a. m.	4.6	74	nw.	8.5	827	4.6		nw.	
8:10 a. m.	4.8	71	nw.	8.5	1,441	6.4		wnw.	
8:23 a. m.	4.9	71	nw.	8.0	1,716	4.5		wnw.	
8:38 a. m.	5.0	69	nw.	8.0	2,081	1.7		wnw.	
8:56 a. m.	5.0	69	nw.	8.5	2,372	− 0.6		wnw.	
9:14 a. m.	5.7	68	nw.	6.7	3,206	− 8.5		wnw	
9:47 a. m.	6.1	57	nw.	5.8	3,749	−12.5		wnw.	
10:14 a. m.	6.9	60	nw.	7.2	3,208	− 9.1		wnw	
10:36 a. m.	7.2	56	nw.	5.8	2,686	− 4.3		wnw.	
10:50 a. m.	7.8	53	nw.	6.7	2,133	0.3		wnw.	
11:02 a. m.	7.9	51	nw.	5.4	1,624	4.6		wnw.	
11:18 a. m.	8.3	42	nw.	5.4	656	8.3		nw.	
11:24 a. m.	8.2	42	nw.	5.4	526	8.2	42	nw.	5.4

December 14, 1909.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 4,000 m., at the maximum altitude.

From 3/10 to 8/10 A.-Cu. moving from the northwest, were present from the beginning to 10:30 a. m. and from 4/10 to 8/10 Ci. thereafter. A solar halo was visible from 8:45 a. m. to 9:17 a. m.

Pressure was low over the Great Lakes, with a secondary depression over the North Carolina coast. Pressure was high over Nevada and Colorado.

December 15, 1908.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 6,000 m.; at maximum altitude, 5,670 m.

The sky was overcast with Ci.-St. moving from the west-northwest and A.-St. moving from the northwest. A solar halo was visible after 8:15 a. m.

High pressure was central over western North Carolina. Pressure was relatively low over the St. Lawrence Valley.

December 16, 1908.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 6,000 m., at maximum altitude.

From 2/10 to a few Ci.-Cu. moving from the west were visible until 11:00 a. m. From 2/10 to 6/10 A.-Cu. from the west-northwest were visible from 8:40 to 9:15 a. m., and from 11:08 until the close of the flight.

A high was central over Ohio and a low over New Brunswick.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
December 17, 1908:									
8:47 a. m	— 0.1	100	se.	8.3	526	— 0.1	100	se.	8.8
9:08 a. m.	— 0.2	100	se.	7.2	777	— 1.2	......	se.	....
9:50 a. m.	— 0.1	100	se.	6.3	967	— 1.9	......	sse.	....
10:16 a. m	— 0.1	100	se.	6.7	1,280	— 1.0	......	s.	....
11:07 a. m.	— 0.3	100	se.	6.7	1,768	4.0	......	sw.	....
11:17 a. m.	— 0.4	100	se.	6.3	2,106	4.4	......	wsw.	....
11:38 a. m	— 0.6	100	se.	7.6	526	— 0.6	100	se.	7.6
December 18, 1908:									
9:48 a. m	9.6	88	w.	4.0	526	9.6	88	w.	4.0
9:56 a. m.	11.7	85	sw.	8.0	912	18.5	......	wsw.	....
10:04 a. m	12.9	81	sw.	8.5	1,217	11.5	......	w.	....
10:20 a. m	14.6	73	sw.	6.7	1,884	7.5	......	w.	....
10:35 a. m.	15.0	73	sw.	5.8	2,399	3.0	......	w.	....
10:42 a. m.	15.0	73	sw.	5.8	526	15.0	73	sw.	5.8
December 19, 1908:									
7:46 a. m.	— 3.1	78	nnw.	3.1	526	— 3.1	78	nnw.	3.1
7:58 a. m.	— 2.8	76	nnw.	3.6	871	— 2.6	......	wnw.	....
8:38 a. m.	— 1.8	73	se.	0.7	1,543	— 5.8	......	w.	....
9:09 a. m.	— 0.8	68	sse.	1.3	1,916	— 3.0	......	w.	....
9:38 a. m.	— 0.6	69	sse.	2.7	2,335	— 3.9	......	w.	....
9:53 a. m.	— 0.4	69	s.	2.7	2,834	— 8.1	......	w.	....
10:16 a. m.	— 0.3	66	s.	3.6	3,130	— 9.7	......	w.	....
10:48 a. m.	1.8	64	s.	2.7	2,804	— 8.7	......	w.	....
11:10 a. m.	1.1	70	ssw.	4.0	2,127	— 4.0	......	w.	....
11:23 a. m.	1.3	78	ssw.	3.1	1,666	— 2.2	......	w.	....
11:33 a. m.	0.6	76	ssw.	3.6	1,419	— 6.7	......	w.	....
11:41 a. m.	1.1	71	ssw.	2.7	1,180	— 4.3	......	w.	....
11:50 a. m.	1.1	71	ssw.	2.7	526	1.1	71	ssw.	2.7

December 17, 1908.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 3,000 m., at maximum altitude.

Dense fog prevailed thruout the flight. Light rain began at 9:40 a. m. and continued thru the night.

Pressure was low over Missouri and high over Ontario, with relatively high pressure over southern Florida.

December 18, 1908.—Two kites were used; lifting surface, 10.8 sq. m. Wire out, 3,400 m., at maximum altitude.

From 2/10 to 5/10 St.-Cu. were visible during the flight.

An active low was central over Lake Erie, with a secondary depression over the New Jersey coast. Pressure was high west of the Mississippi and over Florida.

December 19, 1908.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 6,200 m., at maximum altitude.

From 1/10 to 2/10 Ci. moving from the west were visible until 8:46 a. m. From 1/10 to 9/10 St.-Cu. from the west were visible during the entire flight. The head kite was in the clouds from 9:26 to 10:19 a. m. and from 11:23 to 11:33 a. m.

A low was central over Lake Superior. A high, central over Idaho, covered the entire western and southern portions of the country.

RESULTS OF KITE FLIGHTS.

	° C.	%		p. s.	Meters.	° C.	%		p. s.
December 21, 1908:									
7:30 a. m.	2.7	45	w.	6.7	526	2.7	45	w.	6.7
7:41 a. m.	2.7	41	w.	6.7	909	−1.0	......	w.	....
7:54 a. m.	2.2	45	w.	6.3	1,290	−4.5	......	w.	....
8:06 a. m.	2.4	44	w.	6.3	1,840	−6.2	......	wnw.	....
9:50 a. m.	1.8	45	wnw.	6.3	2,565	−8.8	......	w.	....
10:18 a. m.	2.7	44	wnw.	5.8	1,752	−6.9	......	wnw.	....
10:55 a. m.	3.3	45	w.	6.7	1,226	−4.9	......	wnw.	....
11:07 a. m.	3.3	44	w.	6.3	859	−1.6	......	w.	....
11:12 a. m.	3.5	43	w.	6.3	526	3.5	43	w.	6.3
December 22, 1908:									
8:22 a. m.	−2.1	66	ese.	4.9	526	−2.1	66	ese.	4.9
8:32 a. m.	−2.6	71	ese.	4.5	878	−4.2	......	ese.	....
9:19 a. m.	−2.7	74	ese.	4.9	1,125	−7.0	......	ese.	....
10:06 a. m.	−3.3	92	ese.	8.5	1,217	−8.0	......	ese.	....
10:14 a. m.	−3.3	92	ese.	8.9	1,380	−8.0	......	e.	....
10:33 a. m.	−3.5	94	e.	8.0	1,189	−2.4	......	e.	....
10:48 a. m.	−3.5	94	e.	7.6	865	−7.0	......	e.	....
11:02 a. m.	−3.7	97	e.	8.0	526	−3.7	97	e.	8.0
December 23, 1908:									
7:52 a. m.	−3.2	95	nw.	8.9	526	−3.2	95	nw.	8.9
8:01 a. m.	−3.2	95	nw.	8.9	816	−6.6	......	n.	....
8:22 a. m.	−7.8	94	nw.	9.8	1,171	−0.6	......	n.	....
8:51 a. m.	−7.2	91	n.	10.8	1,867	−0.9	......	nne.	....
9:15 a. m.	−7.2	90	n.	10.8	2,356	−5.2	......	n.	....
10:50 a. m.	−4.7	58	nw.	10.7	2,874	−4.6	......	n.	....
11:09 a. m.	−4.5	80	nw.	10.7	2,731	−5.1	......	n.	....
11:31 a. m.	−3.3	75	nw.	9.8	2,210	−2.6	......	n.	....
11:50 a. m.	−3.6	76	nw.	8.9	1,554	0.4	......	n.	....
11:55 a. m.	−3.6	69	nw.	8.5	968	2.1	......	n.	....
12:10 p. m.	−3.2	67	nw.	7.2	759	−3.4	......	nnw.	....
12:16 p. m.	−2.9	69	nw.	7.2	526	−2.9	69	nw.	7.2

December 21, 1908.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 6,000 m., at maximum altitude.

At the beginning of the flight 2/10 Ci.-St., moving from the west and 6/10 A.-St. moving from the west-southwest were observed. During the flight the Ci.-St. increased to 6/10 and the A.-St. decreased to 3/10. A solar halo was visible from 10:55 a. m. to the end of flight.

A low pressure area was central over Ontario. A high, central over Utah, extended eastward to the South Atlantic States.

December 22, 1908.—Three kites were used; lifting surface, 19.4 sq. m. Wire out, 3,200 m.; at maximum altitude, 2,900 m.

The sky was covered with St. until 9:30 a. m. and with Nb. thereafter. The direction was east-southeast until 10:15 a. m. and east thereafter. Light snow began at 9:30 a. m. and continued until the close of the flight. The head kite was obscured by clouds from 10:06 to 10:35 a. m. and occasionally between 10:50 and 10:56 a. m.

A high was central over the upper St. Lawrence and a low over Georgia and Florida.

December 23, 1908.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 6,000 m.; at maximum altitude, 4,500 m.

A few St.-Cu. were visible until 8:45 a. m.

A ridge of high pressure extended from New England to Louisiana. Pressure was relatively low off Nantucket.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.								
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
December 24, 1908:									
7:14 a. m.	−5.6	96	sse.	6.0	526	− 5.6	96	sse.	6.0
7:25 a. m.	−5.6	96	sse.	6.0	576	....	.....	ssw.	....
7:32 a. m.	−5.6	92	se.	6.0	999	2.9	.....	wsw.	....
8:08 a. m.	−5.7	100	se.	6.7	1,338	3.9	.....	sw.	....
8:27 a. m.	−6.0	100	se.	5.8	1,892	2.6	.....	wsw.	....
8:55 a. m.	−5.7	100	sse.	6.7	2,788	− 3.8	.....	wsw.	....
9:22 a. m.	−4.5	100	s.	5.3	3,750	−12.2	.....	w.	....
10:23 a. m.	−4.6	100	s.	5.4	2,777	− 5.6	.....	w.	....
10:50 a. m.	−3.3	98	sw.	5.8	1,780	1.6	.....	wsw.	....
11:10 a. m.	−3.3	96	s.	3.6	1,295	3.0	.....	wsw.	....
11:17 a. m.	−2.8	100	s.	4.5	956	5.0	.....	wsw.	....
11:25 a. m.	−4.7	98	sse.	4.5	615	....	.....	sw.	....
11:26 a. m.	−4.7	96	sse.	4.5	526	− 4.7	96	sse.	4.5
December 25, 1908:									
8:50 a. m.	4.9	69	wsw.	6.8	526	4.9	69	wsw.	6.8
9:02 a. m.	4.1	73	wsw.	5.8	880	4.0	.....	w.	....
9:50 a. m.	3.1	78	wsw.	6.3	1,633	− 2.4	.....	wnw.	....
10:21 a. m.	3.4	77	w.	6.0	1,902	− 4.0	.....	w.	....
10:40 a. m.	3.8	76	w.	6.0	2,607	− 8.5	.....	w.	....
11:10 a. m.	4.4	74	w.	5.4	3,091	−13.0	.....	wsw.	....
12:02 p. m.	4.4	76	w.	4.5	3,430	−18.2	.....	w.	....
12:15 p. m.	4.7	73	w.	4.5	3,078	−15.5	.....	w	....
12:30 p. m.	4.9	71	w.	4.9	2,508	− 9.7	.....	w.	....
12:44 p. m.	4.6	74	w.	4.5	2,081	− 5.6	.....	wnw.	....
12:50 p. m.	4.6	74	w.	4.5	1,468	− 1.6	.....	wnw.	....
1:05 p. m.	4.7	74	wnw.	4.5	1,192	− 0.6	.....	nw.	....
1:15 p. m.	4.8	71	wnw.	4.5	798	2.3	.....	nw.	....
1:21 p. m.	4.4	74	wnw.	4.5	526	4.4	74	wnw.	4.5
December 26, 1908:									
8:36 a. m.	−1.6	78	nw.	13.4	526	− 1.6	78	nw.	13.4
8:41 a. m.	−1.6	77	nw.	12.5	849	− 5.3	.....	wnw.	....
8:57 a. m.	−1.6	78	wnw.	15.6	1,090	− 7.6	.....	wnw.	....
9:12 a. m.	−1.5	74	wnw.	17.9	1,688	−12.2	.....	wnw.	....
9:33 a. m.	−1.3	70	wnw.	17.0	1,279	− 8.6	.....	wnw.	....
9:52 a. m.	−1.3	68	wnw.	15.1	856	− 4.7	.....	wnw.	....
9:57 a. m.	−1.1	68	wnw.	15.2	526	− 1.1	68	wnw.	15.2

December 24, 1908.—Three kites were used; lifting surface, 16.9 sq. m. Wire out, 6,200 m., at maximum altitude.

Low St. clouds, the base about 50 m. above the mountain at the beginning of the flight, gradually lowered, enveloping the station in light fog at 8:40 a. m. and dense fog from 9:05 a. m. to 9:34 a. m. Thereafter the fog gradually dissipated, and the leading kite was visible after 10.07 a. m. beneath a layer of St.-Cu. moving from the west and covering the whole sky.

Pressure was high over the Atlantic coast States, and low over Lake Superior.

December 25, 1908.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,800 m.; at maximum altitude, 5,000 m.

From 2/10 to 4/10 A.-St. moving from the west-southwest were visible until 11:53 a. m. From 1/10 to 8/10 St. moving from the west were visible thruout the flight. The head kite disappeared at 11:59 a. m. for about five minutes.

A low was central over Lake Huron, and a high over Utah and Colorado.

December 26, 1908.—Two kites were used; lifting surface, 10.8 sq. m. Wire out, 2,500 m., at maximum altitude.

Snow fell until 8:50 a. m., when 1/10 Ci.-St. and 8/10 St.-Cu. moving from the west-northwest were visible. Only 6/10 St.-Cu. were present at the end. Small St.-Cu. past under the head kite at 9:04 a. m.

Low pressure was central east of Maine. Pressure was high over the Gulf States.

RESULTS OF KITE FLIGHTS.

December 28, 1908:	° C.	%		p. s.	Meters.	° C.	%		p. s.
8:06 a. m.	−1.7	53	nnw.	5.4	526	−1.7	53	nnw.	5.4
9:00 a. m.	−0.6	50	nw.	5.4	940	3.6	......	nw.	......
9:21 a. m.	0.1	52	nw.	5.4	1,156	2.9	......	nw.	......
9:32 a. m.	0.3	54	nw.	5.4	942	3.8	......	nw.	......
9:38 a. m.	0.4	49	nw.	3.6	526	0.4	49	nw.	3.6
December 29, 1908:									
7:23 a. m.	1.7	75	wnw.	8.5	526	1.7	75	wnw.	8.5
7:30 a. m.	1.9	73	wnw.	9.8	851	1.3	......	nw.	......
7:40 a. m.	2.0	75	wnw.	8.9	1,187	1.9	......	nw.	......
7:50 a. m.	2.2	74	wnw.	8.5	1,628	2.0	......	nnw.	......
7:54 a. m.	2.1	76	wnw.	8.5	1,782	4.1	......	nnw.	......
8:00 a. m.	2.1	76	wnw.	8.5	2,166	2.7	......	nnw.	......
8:18 a. m.	2.0	77	wnw.	7.2	2,500	0.1	......	nw.	......
8:37 a. m.	2.2	71	wnw.	6.7	3,048	−3.8	......	nw.	......
9:20 a. m.	3.7	62	wnw.	6.7	3,877	−11.3	......	wnw.	......
9:41 a. m.	3.6	68	w.	4.5	3,512	−7.9	......	wnw.	......
10:15 a. m.	4.7	56	wnw.	4.9	2,548	0.2	......	wnw.	......
10:34 a. m.	5.0	54	wnw.	4.5	1,907	4.2	......	wnw.	......
10:39 a. m.	5.0	54	wnw.	4.0	1,704	5.1	......	nnw.	......
10:48 a. m.	5.0	54	wnw.	4.9	1,259	3.4	......	nnw.	......
10:59 a. m.	5.2	54	wnw.	2.7	526	5.2	54	wnw.	2.7
December 30, 1908:									
7:31 a. m.	1.7	81	se.	6.3	526	1.7	81	se.	6.3
7:40 a. m.	1.2	81	se.	5.8	910	1.5	......	s.	......
8:00 a. m.	1.1	81	se.	6.7	1,447	5.5	......	sw.	......
8:27 a. m.	1.6	84	se.	9.0	2,166	−0.5	......	sw.	......
8:30 a. m.	1.6	84	se.	6.0	2,425	1.0	......	sw.	......
9:05 a. m.	1.1	87	se.	8.0	2,965	−1.0	......	sw.	......
9:26 a. m.	1.1	90	se.	8.9	2,758	−1.2	......	sw.	......
9:47 a. m.	1.3	87	se.	7.2	526	1.3	87	se.	7.2
December 31, 1908:									
8:33 a. m.	1.4	56	wnw.	10.7	526	1.4	56	wnw.	10.7
8:40 a. m.	1.3	57	wnw.	10.7	902	−0.6	......	wnw.	......
8:53 a. m.	1.1	58	wnw.	15.2	1,187	−2.5	......	wnw.	......
9:08 a. m.	1.0	55	wnw.	14.8	1,622	−5.0	......	nw.	......
9:36 a. m.	0.6	52	wnw.	16.1	1,954	0.9	......	nw.	......
10:10 a. m.	0.4	52	nw.	21.5	1,647	−3.5	......	nw.	......
11:09 a. m.	0.3	53	nw.	16.1	1,215	−6.5	......	wnw.	......
11:20 a. m.	0.5	53	nw.	16.1	841	−3.4	......	wnw.	......
11:27 a. m.	0.7	45	nw.	15.2	526	0.7	45	nw.	15.2

December 28, 1908.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 1,737 m.; at maximum altitude, 1,550 m.

At the beginning 1/10 A.-St. and 8/10 A.-Cu. moving from the west were present. At 9:19 a. m. 2/10 Ci.-Cu. and 5/10 A.-Cu. were present and continued during the remainder of the flight.

High pressure was central over Virginia and was low over New Brunswick.

December 29, 1908.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 6,200 m., at maximum altitude.

Ci.-St. moving from the west-northwest increased from few at 8:30 a. m. to 3/10 at the end of the flight.

High pressure, central over the station, covered the eastern United States.

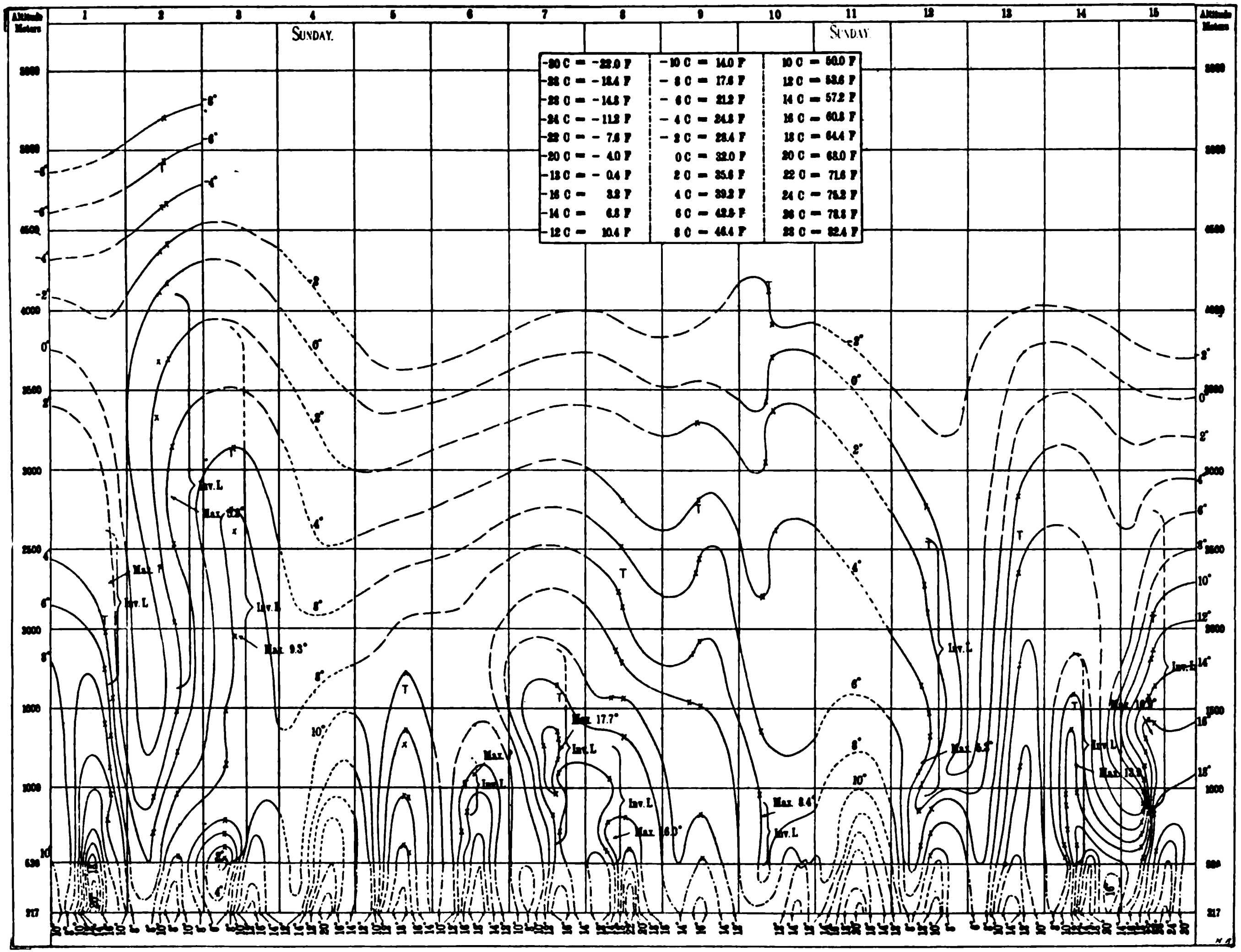
December 30, 1908.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 5,500 m., at maximum altitude.

The sky was covered with St. moving from the southwest thruout the flight. The head kite was in the clouds from 8:30 to 9:26 a. m.

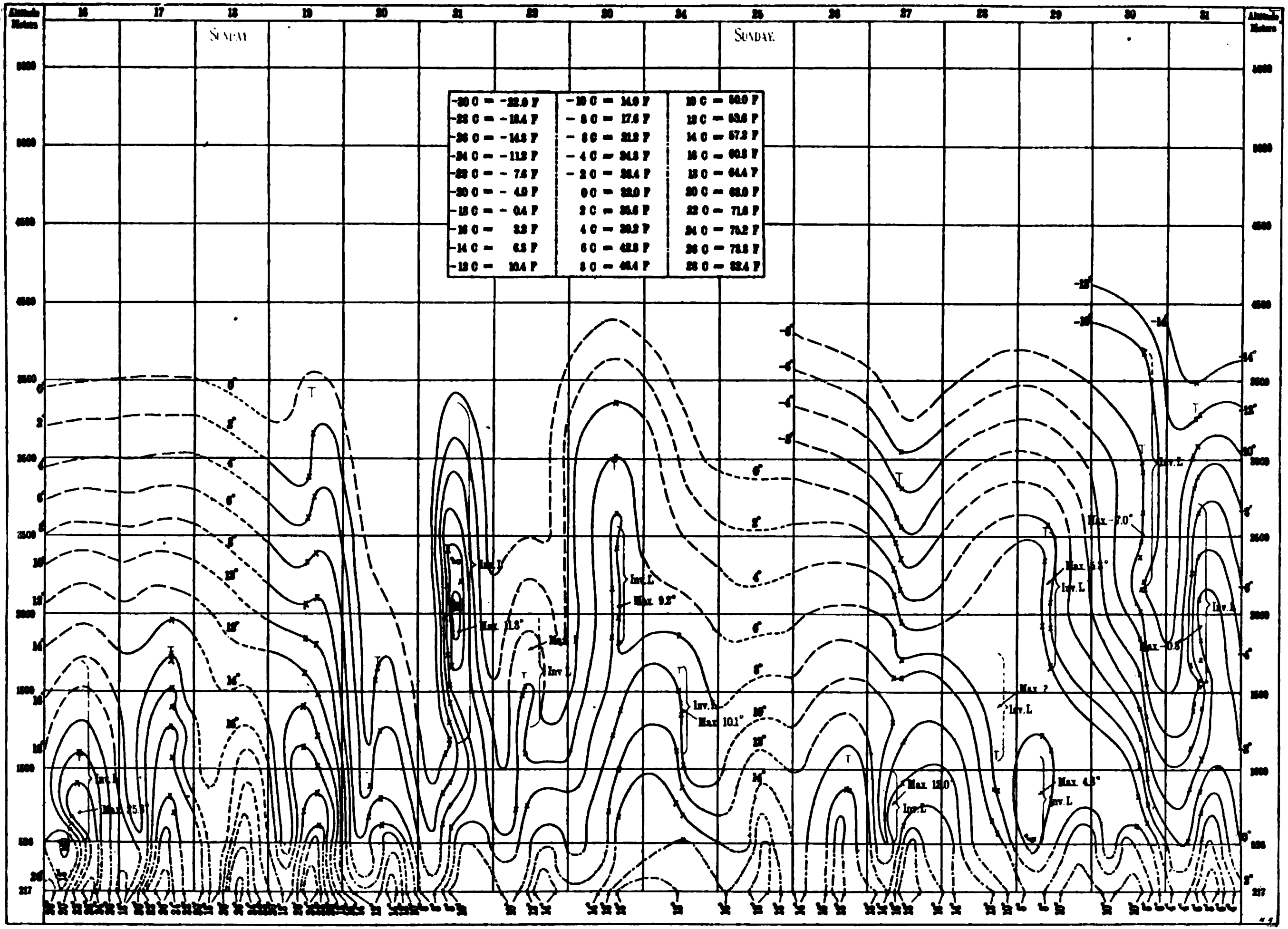
A high was central over New Brunswick and a low over Lake Superior.

December 31, 1908.—Three kites were used; lifting surface, 12.8 sq. m. Wire out, 5,000 m., at maximum altitude. The sky was cloudless.

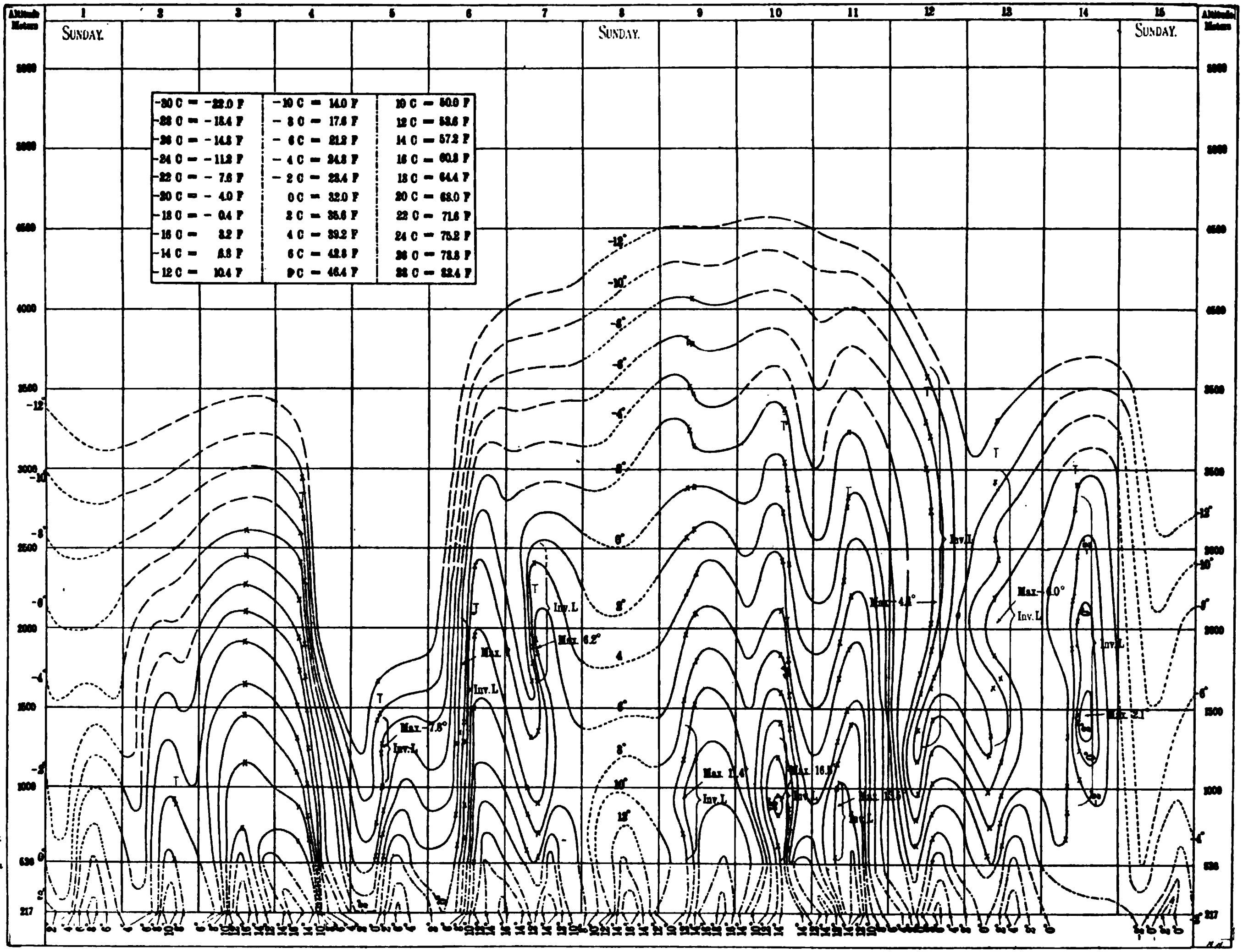
An extensive area of high pressure, central over the Dakotas, covered practically the whole country, excepting New York and New England. A low was over the lower St. Lawrence.



Upper air isotherms, October 1-15, 1908.



Upper air isotherms, October 16–31, 1908.



Upper air isotherms, November 1–15, 1908.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
December 7, 1908:	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
9:22 a. m.	1.4	100	nw.	10.7	526	1.4	100	nw.	10.7
9:34 a. m.	2.4	100	nw.	10.7	807	3.6	......	wnw.	....
9:47 a. m	8.7	100	nw.	9.8	1,124	8.0	......	wnw.	....
10:15 a. m.	8.1	100	nw.	10.8	1,595	1.5	......	w.	....
10:47 a. m	3.7	100	nw.	9.8	2,000	−1.3	......	w.	....
11:28 a. m.	3.8	100	nw.	9.8	3,012	−6.2	......	sw.	....
11:58 a. m.	3.8	97	nw.	20.6	2,357	−2.4	......	wsw.	....
12:20 p. m	4.0	84	nw.	20.6	1,745	3.4	......	w.	....
12:38 p. m	4.2	72	nw.	17.9	1,824	3.4	......	wnw.	....
12:50 p. m	4.3	68	nw.	18.8	1,086	0.1	......	wnw.	....
1:09 p. m	4.0	66	nw.	18.4	777	1.3	......	wnw.	....
1:13 p. m	4.1	65	nw.	12.5	526	4.1	65	nw.	12.5
December 8, 1908:									
7:41 a. m.	−6.7	70	nw.	10.7	526	−6.7	70	nw.	10.7
7:56 a. m	−6.7	70	nw.	9.4	897	−10.4	......	nw.	....
8:27 a. m.	−6.3	70	nw.	9.4	1,518	−5.2	......	nw.	....
8:52 a. m	−6.1	70	nw.	9.4	1,762	−2.5	......	wnw.	....
9:15 a. m.	−5.9	63	nw.	12.1	2,789	−9.0	......	w.	....
10:17 a. m.	−5.0	57	nw.	10.7	3,415	−14.6	......	w.	....
10:58 a. m.	−4.3	57	nw.	8.9	2,630	−8.4	......	w.	....
11:24 a. m.	−3.9	54	nw.	7.2	1,793	−8.6	......	wnw.	....
11:38 a. m	−3.3	52	nw.	6.3	1,375	−5.9	......	nw.	....
11:44 a. m.	−3.3	52	nw.	7.2	908	−9.6	......	nw.	....
11:51 a. m.	−2.8	53	nw.	7.2	526	−2.8	53	nw.	7.2
December 9, 1908:									
7:25 a. m.	−2.1	66	sw.	4.5	526	−2.1	66	sw.	4.5
7:41 a. m	−1.9	58	sw.	5.4	914	−4.8	......	wsw.	....
8:00 a. m.	−1.7	56	sw.	6.3	1,287	−8.7	......	w.	....
8:20 a. m	−1.3	60	sw.	6.3	1,634	−12.4	......	wnw.	....
8:40 a. m	−1.1	60	sw.	5.8	1,844	−9.9	......	wnw.	....
9:14 a. m.	−0.1	50	sw.	6.3	2,698	−13.8	......	wnw.	....
10:09 a. m	−0.4	58	w.	6.3	2,167	−11.7	......	wnw.	....
10:30 a. m.	−0.7	68	w.	5.8	1,821	−12.4	......	wnw.	....
10:40 a. m	−0.6	69	nw.	4.9	1,558	−11.7	......	wnw.	....
10:48 a. m.	−0.6	69	w.	4.9	1,218	−9.3	......	wnw.	....
10:55 a. m.	−0.6	69	w.	4.9	777	−5.8	......	w.	....
10:59 a. m.	−0.2	66	w.	4.5	526	−0.2	66	w.	4.5

December 7, 1908.—Three kites were used; lifting surface, 16.2 sq. m. Wire out, 6,000 m., at maximum altitude.

Light rain and dense fog prevailed at the beginning. The rain ended at 9:44 a. m. and the fog lifted at 11:40 a. m. 3/10 A.-St. and 5/10 S.-Cu. moving from the southwest were present after 11:40 a. m. The sky was clearing in the northwest. The S.-Cu. were not reached by the kites.

Low pressure was central over Lake Huron. Pressure was high over the Gulf of St. Lawrence and eastern Kansas.

December 8, 1908.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 6,000 m.; at maximum altitude, 5,500 m.

A few Ci.-St. were visible near the horizon.

A high was central over the lower Mississippi Valley, and a low over the Gulf of St. Lawrence.

December 9, 1908.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 6,000 m., at maximum altitude.

At the beginning 10/10 St. moving from the west-northwest were present. These began to disappear rapidly at 8:40 a. m. and at 9:10 a. m. the sky was almost clear. A thin sheet of high clouds formed, producing a solar halo which lasted from 9:14 to 9:20 a. m. The clouds lowered rapidly and snow began at 9:42 a. m. and continued during the remainder of the flight. The base of the clouds from which the snow was falling was about 1,200 m. above sea level.

High pressure was central over Mississippi, and was relatively low over Vermont.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.				At different heights above sea.				
	Air temperature.	Rel. hum.	Wind.		Height.	Air temperature.	Rel. hum.	Wind.	
			Dir.	Velocity.				Dir.	Velocity.
	° C.	%		Meters p. s.	Meters.	° C.	%		Meters p. s.
December 10, 1908:									
7:15 a. m.	— 6.8	68	n.	4.0	526	— 6.8	68	n.	4.0
7:22 a. m.	— 6.9	68	n.	3.6	651	— 7.2	......	nnw.	....
7:48 a. m.	— 6.3	66	nw.	3.6	898	— 9.5	......	nnw.	....
8:16 a. m.	— 5.8	59	nw.	2.7	701	— 7.2	......	nnw.	....
8:37 a. m.	— 5.0	57	nw.	2.7	526	— 5.0	57	nw.	2.7
December 11, 1908:									
7:30 a. m.	— 3.3	85	s.	5.4	526	— 3.3	85	s.	5.4
7:40 a. m.	— 3.1	83	s.	5.4	984	5.2	......	wsw.	....
7:59 a. m.	— 3.1	85	s.	5.4	1,227	4.9	......	wsw.	....
8:26 a. m.	— 2.2	80	sw.	7.2	2,120	— 1.5	......	wsw.	....
8:37 a. m.	— 1.7	78	sw.	5.4	2,556	— 1.9	......	wsw.	....
8:40 a. m.	— 1.7	78	sw.	5.4	526	— 1.7	78	sw.	5.4
December 12, 1908:									
8:31 a. m.	— 0.2	79	nw.	17.4	526	— 0.2	79	nw.	17.4
8:40 a. m.	— 0.4	81	nw.	17.9	1,019	— 3.9	......	nw.	....
9:05 a. m.	— 0.6	79	nw.	13.9	1,247	— 7.7	......	wnw.	....
9:29 a. m.	— 0.4	76	nw.	14.8	1,705	—11.5	......	wnw.	....
9:40 a. m.	— 0.2	69	nw.	18.8	2,211	— 7.2	......	wnw.	....
10:09 a. m.	0.0	69	nw.	19.7	1,964	— 3.7	......	nw.	....
10:37 a. m.	— 0.6	63	nw.	19.7	1,611	— 5.7	......	nw.	....
10:59 a. m.	— 0.9	64	nw.	14.3	1,297	— 8.5	......	wnw.	....
11:15 a. m.	— 0.4	58	nw.	18.9	826	— 4.0	......	wnw.	....
11:23 a. m.	— 0.8	59	nw.	13.9	526	— 0.8	59	nw.	13.9

December 10, 1908.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 1,000 m.; at maximum altitude, 800 m.

A few St.-Cu. were observed near the western horizon at the beginning of the flight; at 7:40 a. m. a few Ci. appeared moving from the northwest.

An area of high pressure central over northern New York overlay States east of the Mississippi River. Pressure was low over Manitoba and Kansas.

December 11, 1908.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 3,000 m., at maximum altitude.

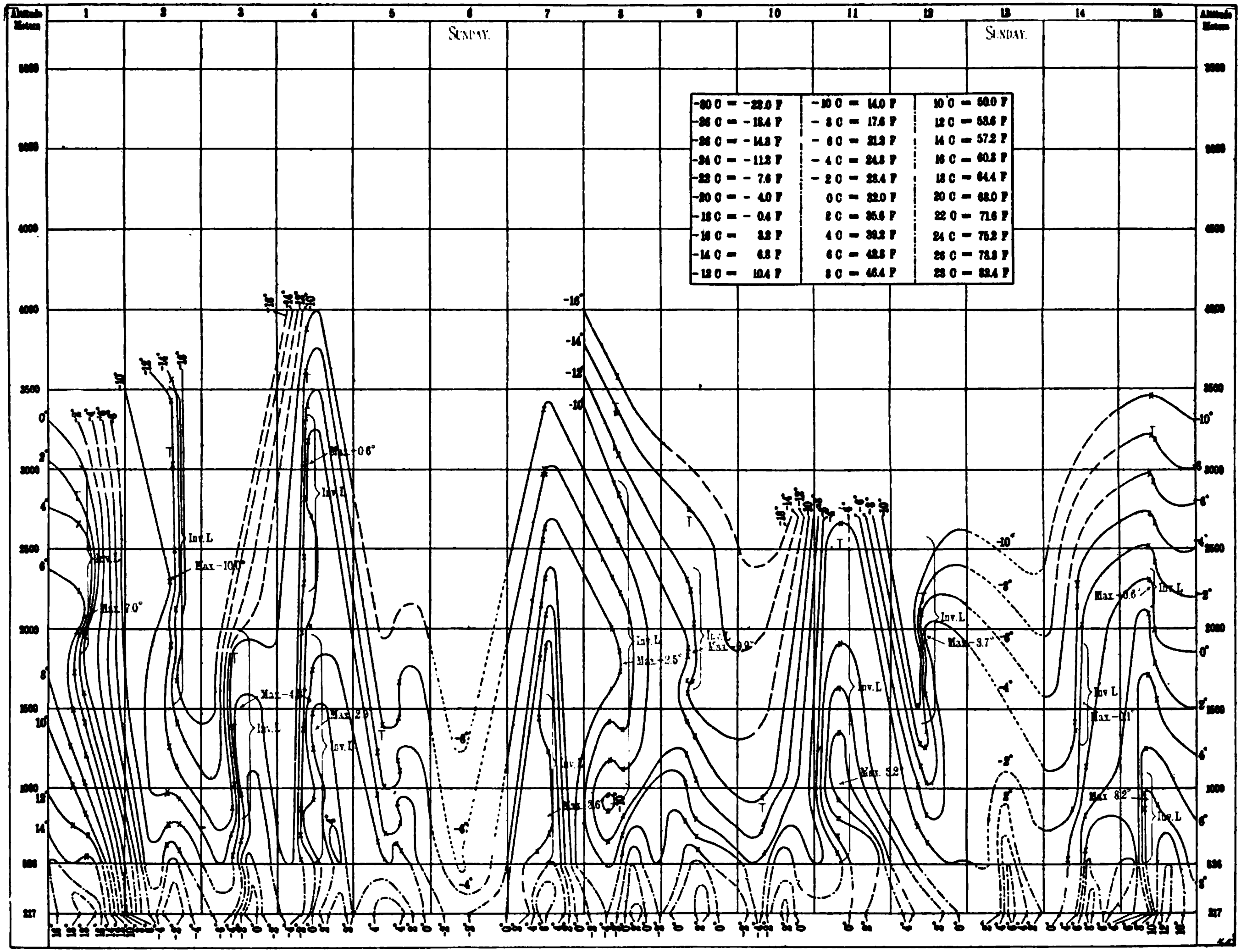
The sky was covered with St. moving from the west-southwest until 8:30 a. m. and with Nb. thereafter. Heavy snow began at 8:30 a. m. and continued until the end of the flight. Just before the snow began an unusually heavy electric discharge was observed, when the earth connection at the reel was broken.

A low was central over the upper Lakes. High pressure prevailed along the Atlantic coast.

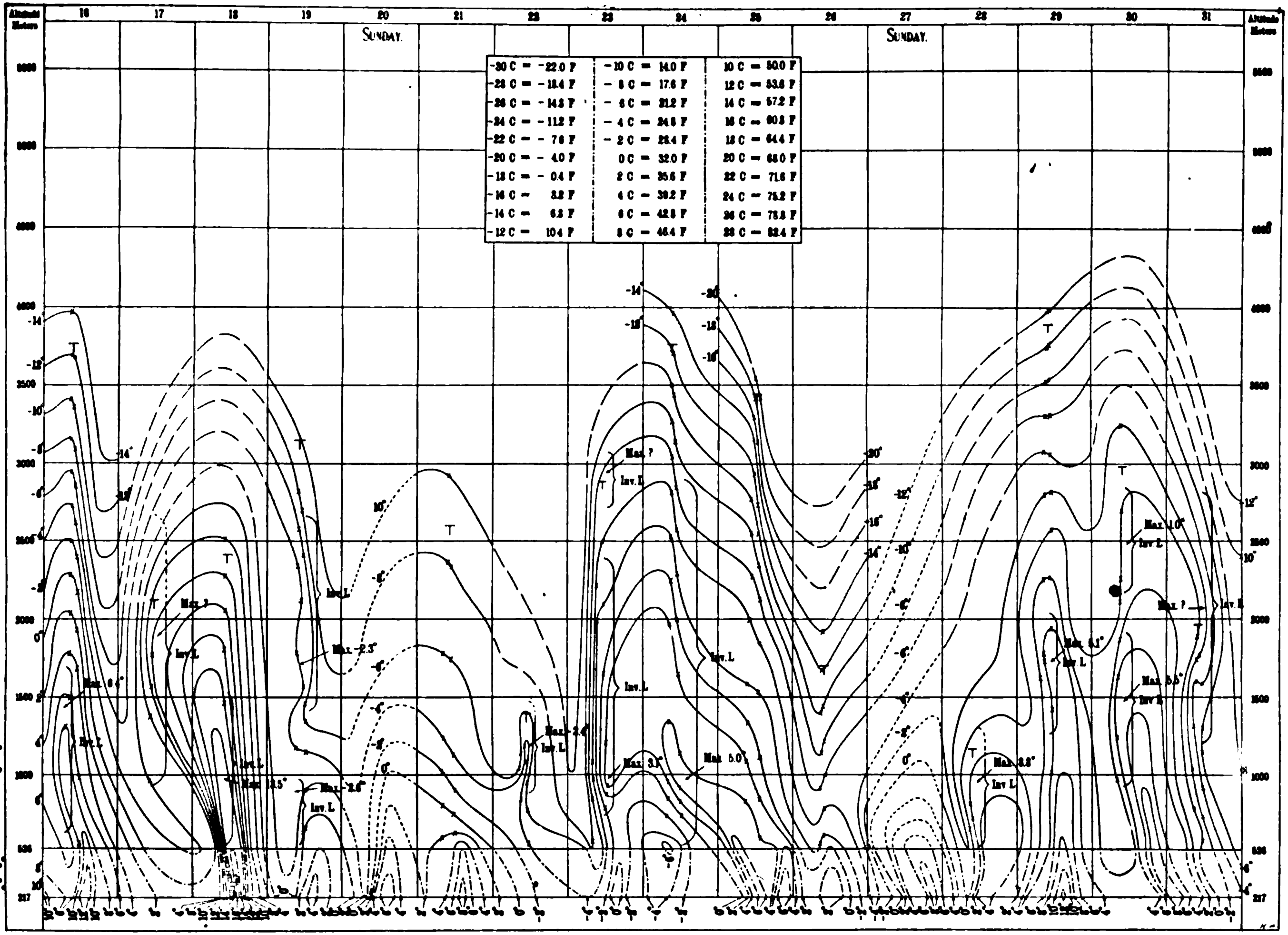
December 12, 1908.—Two kites were used; lifting surface, 10.8 sq. m. Wire out, 5,000 m., at maximum altitude.

St.-Cu. moving from the west-northwest, with a lower layer from the northwest, nearly covered the sky until 9:15 a. m. By 9:45 a. m. only 3/10 St.-Cu. moving from the west-northwest were visible. Ci.-Cu. moving from the west appeared about 10 a. m. At the end 1/10 each Ci.-Cu. and St.-Cu. were present. The head kite entered the St.-Cu. at 8:43 a. m. at about 1,170 m. The clouds cleared away from the kites at 9:55 a. m. The last 500 m. of wire was covered with frost.

Low pressure was central over Nantucket. Pressure was relatively high over Mississippi.



Upper air isotherms, December 1-15, 1908.



Upper air isotherms, December 16–31, 1908.

Stationary cloud.

W. B. No. 418. Issued December 11, 1909.

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PREPARED UNDER THE DIRECTION OF

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CHIEF U. S. WEATHER BUREAU

WASHINGTON
U. S. WEATHER BUREAU
1909

CONTENTS.

CERTAIN LAWS OF RADIATION AND ABSORPTION AND A FEW OF THEIR APPLICATIONS.

By W. J. Humphreys.

INTRODUCTION.

The surface of the earth is heated almost wholly by absorption of solar radiation, of which fully three-fourths of the energy belongs to the short wave spectral region between .4μ (violet) and 1.1μ (ultrared), and is cooled by counter terrestrial radiation of comparatively long wave lengths, the maximum intensity being in the neighborhood of 12μ. Both phenomena, so far as the effects at any given locality are concerned, necessarily are complicated by the winds and by evaporation and condensation, all of which do much toward the equalization of surface temperatures. But, for the earth as a whole and the gases surrounding it, heating and cooling are results of selective absorption in one spectral region and selective radiation in quite another; nor is there any necessary close relation between the two. That is, a good or bad absorber of solar radiations, is not, in general, an equally good or poor emitter of relatively long wave length terrestrial radiations. The better the absorber, other things being equal, the warmer it gets during insolation, and the more it heats the air, while the better radiator it is, the colder, as a rule, it and the air adjacent become during the night.

When the atmosphere is clear and dry, and therefore diathermanous, the cooling of objects and their liability to frost depends largely upon their capacity to radiate at ordinary temperatures. A good radiator under these conditions loses heat partly by radiation through the atmosphere to space. It cools rapidly, but the heat it gives off does not all go to warming the air, for, as explained, a part of it is directly lost to space. On the other hand an object that radiates poorly gives off heat more slowly, and what it does give off is in larger measure by conduction to the atmosphere. It tends to conserve both its own temperature and that of the surrounding air, and thereby diminishes the probability of frost.

Evidently then the phenomena of meteorology depend greatly upon the capacity of the surface of the earth and the gases above it to absorb and to give off radiant energy, and therefore it seems worth while to bring together, for convenient reference, the principal laws,

so far as we know them, of radiation and absorption. And this is all the more important since many of the text-book summaries of them are inadequate—in some cases even erroneous.

GENERAL REMARKS.

It is a matter of common experience that cold objects in the neighborhood of a heated body themselves become warmed, and experiment shows that the placing of one or more of the objects in a vacuum does not alter this general result. The hot object we say gives off heat by radiation and is cooled, while the cold ones absorb more or less of this radiation and thereby are warmed. The ultimate mechanism, however, of radiation and of absorption is not understood. We have reason to believe that matter is accompanied by, or probably consists in part—possibly wholly—of electrons which carry, or perhaps simply are, negative charges of the magnitude 10^{-20} in electromagnetic measure, or 3×10^{-10} in electrostatic measure. Now a pendulum-like swing, or an orbital rotation of such a charge would produce electromagnetic waves, whose manifestation at any given distant point must depend in part on the direction and intensity of the magnetic field in which they are generated. And just such generally predeterminable magnetic effects are found to exist when a luminous gas is acted on by a strong magnet. Therefore, and for other reasons too, we believe radiation to be due to some sort of vibration or orbital rotation of electrons in the atom.

Let radiation of the same wave length that a substance is giving out, or that it would give out at a higher temperature, be incident upon it. Absorption will take place, and the temperature of the substance be raised, but by just what process no one can definitely say.

However, it appears that there is a connection between an electron and the surrounding ether such that swings of the first set up vibrations in the latter; and therefore we might expect vibrations of the ether to produce swings of the electron. This merely implies that the absorbing body becomes luminous with the same period radiation as that which it absorbs (which is far from being the whole story even of its radiation) and says nothing about the method by which part at least of the vibrational energy of the ether becomes kinetic energy of the molecules of the absorbing object, that is, by just what process the temperature is raised.

It may be that the heating of an object by absorption, the giving of kinetic energy to its molecules, is due to the accidental "impacts" of atoms whose electrons are highly agitated by the absorbed radiation,

or even to atomic explosion caused by intense electron disturbance. At any rate the intensity of a given radiation, as we know from various types of luminescence, that from the fire fly, for instance, is not always a measure of the temperature of the radiating object, and indeed there may be no necessary close relation between absorption and temperature. In both cases temperature may be only an unessential phenomenon. In other words, even where it accompanies and bears a definite relation to them, it may be neither the proximate cause of radiation nor the proximate effect of absorption.

But no matter what the real mechanism of radiation and of absorption, nor what the means by which temperature is connected with these phenomena, they act, in the case of strictly thermal radiation, according to certain known laws, some of which are general and only qualitative, while others are definite and quantitative.

LUMINESCENCE.

This type of radiation may be classified according to its more or less obvious causes. Thus we have:

1. *Chemical luminescence.*—Illustrated by phosphorescent bacteria, by the firefly, the glow worm, and the like, where the exciting cause apparently is some chemical change, the nature of which is not understood.

2. *Photo luminescence.*—Divisible into (*a*) fluorescence, as splendidly shown by the glow of sodium vapor while, and only while, excited by radiation of certain wave lengths; (*b*) phosphorescence, as illustrated by Balmain's luminous paint, or calcium sulphide, which glows for hours after an exposure to any strong light. Both fluorescence, which ceases with the removal of the exciting cause, and phosphorescence, which continues for a greater or less length of time, evidently are due to some effect of absorption other than temperature change; perhaps chemical. Probably, therefore, they differ from each other mainly in their duration after the exciting radiation is shut off.

3. *Electro luminescence.*—Of which good examples are seen in the glows of electrodeless tubes, and often of electric light bulbs when properly excited. At times this glow is most fleeting, but at others it is more or less persistent. Probably under this head will come all radiation excited by electric discharges, such as cathode rays, the glow of Geissler tubes, and also the glows excited by X rays and by radium.

4. *Mechanical luminescence.*—Seen in the cutting of glass, in the rubbing together of pieces of quartz, in the crushing of sugar, and in many other similar cases.

5. *Thermo luminescence.*—Where the temperature apparently serves only the purpose of liberating some form of potential energy, as illustrated by the glow of fluorspars when more or less heated.

6. *Cometary luminescence.*—Such as is shown by nebulae and by the tails of comets. This radiation in all probability is not due to temperature, but to just what it actually is due there is very little to suggest even a reasonable guess.

INCANDESCENCE.

In the case of radiation by incandescence temperature alone appears to be the all controlling factor, as illustrated by carbon filaments and metallic wires when heated in vacuo.

In regard to all the above types of radiation, especially those of luminescence, our information of whatever kind, is extremely fragmentary. In fact it is concerning that radiation only, due, directly or indirectly to temperature, and that absorption that appears simply to produce temperature changes, that we have knowledge sufficiently extensive and definite to formulate into laws. Nor does this knowledge extend even approximately to all objects, nor are the more exact quantitative laws applicable except to specially devised and artificially constructed bodies and to bodies with ideal properties such as nowhere exist in nature.

However, a vast deal of labor, both experimental and theoretical, has been given to the phenomena of radiation and absorption, and even the following few laws that have been formulated are of the greatest importance.

PREVOST'S THEORY OF EXCHANGES.

According to this theory[1] any two objects with no intercepting medium between them continue to radiate and mutually to absorb each other's radiation whatever their temperatures. Any object, no matter how cold, sends some heat to its neighbor, no matter how hot, where a part of it at least is absorbed; but the cold object receives from the hot one a greater amount of heat in return.

Accordingly the reading of a bolometer will depend upon its own temperature in part as well as upon that of the object under examination. Let the total radiation per unit area of an object vary as CT^n, in which C is a constant, depending upon the nature of the radiator, T the absolute temperature, and n a number which for the full radiator

[1] Sur l'Equilibre du Feu, Genève, 1792; Du Calorique Rayonnant, Genève, 1809.

or black body is 4. Then where G is the heat gained per second per unit area by the bolometer strip, we have, in the case of no intervening absorbing medium, and no other contributing radiator, $G = \omega_1 C_1 T_1^n - \omega_2 C_2 T_2^{n'}$, in which T_1 is the temperature of the object, T_2 that of the bolometer, ω_1 and ω_2 the solid angles subtended at the bolometer strip by the radiator and the bolometer opening respectively.

UPON WHAT THE RADIATION AND ABSORPTION OF AN OBJECT DEPENDS.

The energy emitted per second by a body through incandescent radiation depends upon its substance or composition, its surface and its temperature, and upon the specific inductive capacity of the surrounding medium, and not in any way upon the composition, temperature, or position of neighboring objects; while the energy absorbed depends upon the nature and condition of the absorbing object and the amount of incident energy, or the condition of surrounding objects.

TWO RELATIONS, QUALITATIVE AND QUANTITATIVE.

It must be kept clearly in mind, as Cotton[1] has emphasized, that there are two distinct relations between radiation and absorption, one merely qualitative, the other quantitative, that commonly are confused. The qualitative relation deals with the radiation and absorption of a single object, while the quantitative relation is that which exists between different bodies. This latter gives the exact relation between the absorption and the radiation, when these terms are properly defined, of any object, and, while the same for all, shows to what extent it depends upon temperature and upon wave length.

RADIATION AND ABSORPTION OF A GIVEN OBJECT, QUALITATIVE.

Whenever any object is emitting radiations of a given wave length and polarization it will absorb identical radiations coming to it from without. In many cases, perhaps commonly, it appears to do more than this. Most objects, even some of the most transparent, such as water and glass, at ordinary temperatures absorb ultraviolet radiations, a type that at these temperatures they are emitting so feebly, if at all, that they have never been detected. Similarly, colored objects absorb radiations which there is no evidence of their emitting at room temperatures. Carbon dioxide, water, and some other substances, when cold absorb lines and bands which at higher temperatures they

[1] Astrophysical Jr. 9. 237, 1899.

appreciably emit, but there is no certainty that this property is universally true. However, it is safe to say that good absorbers are good radiators and poor absorbers poor radiators, though it must be distinctly understood that these are only qualitative rules.

THE ÅNGSTRÖM PRESSURE EFFECT.

Ångström[3] has shown that the absorption of radiant energy by carbon dioxide increases with the density as well as with the quantity of the absorbing gas; and also[4] that the effect is the same, both qualitatively and quantitatively, whether the given increase in pressure be secured by compression into a shorter column of the pure carbon dioxide or by the addition of an inert gas. This interesting investigation has recently been extended[5] to carbon monoxide, water vapor, and a number of other gases, all of which show the same phenomenon, but to unequal extents.

This effect is most pronounced at pressures below one atmosphere, so that in the highest layers of the air reached by sounding balloons, say 25 kilometers above sea level, the absorption by a given amount of carbon dioxide, of water vapor, or presumably of any other gas, is less than half what it would be for identically the same amount of the same gas under normal pressure, such as obtains at the surface of the earth; and at greater elevations still less. This pressure effect, therefore, discovered by Ångström, is of decided meteorological importance, since absorption by a given quantity of a gas changes rapidly with change of elevation, and also at any given elevation with change of barometer.

ABSORPTION BY FLAMES.

An interesting case of the qualitative rule is the absorption by flames and the reversal of spectral lines. When a high temperature flame, such as that of a Bunsen burner, contains the vapor of a metal or some compound of it, it generally gives out radiations characteristic of this metal. And when radiations of these particular wave lengths are incident upon the flame they are absorbed to a greater or less extent. Such radiations however as the flame does not emit it does not absorb. Let the flame of unit thickness emit in a definite direction a quantity R_1 of a given radiation, and let it so absorb radiation of this same wave length that only the nth part of that incident on one side gets through

[3] Ann. d. Phys. 6 p. 163, 1901.

[4] Arkiv. för Matematik, Astronomi och Fysik 4, No. 30, 1908.

[5] E. v. Bahr, Ann. d. Phys. 29, p. 780, 1909.

at the other. The coefficient of absorption, that is, the fraction of the incident given radiation absorbed by a unit thickness of the flame is $1-\frac{1}{n}$, or $\frac{n-1}{n}$, a value independent, apparently, of intensity, and therefore the total value of the radiation given by a flame of infinite thickness, $R_\infty = R_1 + \frac{R_1}{n} + \frac{R_1}{n^2} + \text{etc.} = \frac{nR_1}{n-1}$. In other words the maximum radiation possible for a mass of gas of any depth is the emission of a layer of any thickness, great or small—the unit of length may be anything—divided by the coefficient of absorption of that same layer. Consequently when the spectrum of an incandescent solid is taken through a colored flame the appearance at any given place in the spectrum will depend upon the relative brilliancy at that place of the solid to the flame. Let the depth of the flame be sufficient to give R_∞, then, calling S the radiation of the solid over a narrow spectral region, we have,

$S > \frac{nR_1}{n-1}$, line dark on bright background.

$S = \frac{nR_1}{n-1}$, uniform brilliancy—no line visible.

$S < \frac{nR_1}{n-1}$, line bright on relatively dark background.

The first case gives the phenomenon of true reversal, which is so conspicuously seen in the solar spectrum. Besides this true reversal there occurs, in the case of many metallic lines, what is known as spontaneous reversal. This is also true of certain hydrogen lines, of the bands of cyanogen, and of the bands produced by the fluorides of calcium, of barium, and of strontium. In this case the cooler vapors surrounding the flame absorb greatly the radiations from the hotter vapors nearer its center, radiations which the cool vapors themselves would send out at higher temperatures, and thereby produce lines with dark centers and bright sides. In flame spectra, under certain conditions at least, the brilliancy of the lines, owing probably to chemical action, is greater than the temperature alone could produce.

TRANSMISSION OF SINGLE WAVE-LENGTH RADIATION.

When the observer is on that side of a nonreflecting absorbing medium away from the source, it is easy, by varying the thickness of the absorbing layer, to determine the coefficient of transmission for a given wave length and the intensity of the incident radiation. Let the absorbing medium be a uniform one and let the intensity of the

incident radiation be I_0. Let a be the fraction of the incident radiation transmitted by a layer of unit thickness, then for thicknesses m and n we obtain, respectively, $I_m = I_0 a^m$, and $I_n = I_0 a^n$, in which I_0 and a are unknown. By combining the two observations we get

$$a = \left(\frac{I_m}{I_n}\right)^{\frac{1}{m-n}}, \text{ and } I_0 = I_m \left(\frac{I_m}{I_n}\right)^{\frac{m}{n-m}}.$$

For convenience of computation, if practical, let $n = 2m$. Then

$$a^m = \frac{I_n}{I_m}, \text{ and } I_0 = \frac{I_m^2}{I_n}. \text{ (Equation of Bouguer.)}$$

These equations find practical application in the measurement of the transmissibility of the atmosphere for various solar radiations, and the determination of their intensities just outside the absorbing medium.

TRANSMISSION OF MULTIPLE WAVE-LENGTH RADIATION.

At first it might seem that the above exponential absorption equation of Bouguer for single wave-length radiation would hold for radiation of any number of wave lengths, but, as Langley showed, it does not. Let the intensities of the incident single wave-length radiations be A_0, B_0, C_0, etc., and their respective coefficients of transmission a, b, c, etc. Then their combined intensity, through the thicknesses m and $2m$, will be $A_0 a^m + B_0 b^m + C_0 c^m +$, etc., $= R_m$, and

$A_0 a^{2m} + B_0 b^{2m} + C_0 c^{2m} +$, etc., $= R_{2m}$, respectively.

The intensity of the incident radiation, according to the Bouguer formula is,

$$R_0 = \frac{R^2{}_m}{R_{2m}}.$$

The difference between the real and this calculated value of the incident radiation is

$$A_0 + B_0 + C_0 + \text{etc.} - R_0 = A_0 + B_0 + C_0 + \text{etc.} - \frac{(A_0 a^m + B_0 b^m + C_0 c^m + \text{etc.})^2}{A_0 a^{2m} + B_0 b^{2m} + C_0 c^{2m} + \text{etc.}} =$$

$$\frac{A_0 B_0 (a^m - b^m)^2 + A_0 C_0 (a^m - c^m)^2 + \ldots . + B_0 C_0 (b^m - c^m)^2 + \text{etc.}}{A_0 a^{2m} + B_0 b^{2m} + C_0 c^{2m} + \text{etc.}}.$$

An occasional term in the numerator may reduce to zero, since possibly $a = k$, $c = l$, etc., but in general no two of the coefficients a, b, c, etc, are equal to each other. Therefore every term, except the few zero ones, if such exist, and consequently the whole fraction, is real and positive, and the calculated value, according to the Bouguer formula, of the intensity of the insolation too small. This is because the Bouguer formula erroneously supposes the coefficients of transmission to be the same for all wave lengths.

This shows that integrating pyrheliometers give too small values of

the solar constant, and that only a delicate bolometer can give accurate or standard values.

LIGHT PRESSURE.

Consider a parallel beam of uniformly intense radiant energy moving in the direction x. Let an object that completely absorbs this energy be put in its path and have a cross section q at right angles to x. Further let this absorbing object move along x in the same direction as the radiation and at the same speed. No energy will be absorbed. Now let it move somewhat slower. After a time t there will be a difference l between the distance traversed by the radiant energy and by the absorber. If e is the radiant energy per unit volume, then the amount of energy absorbed will be given by the expression $W=qle$. This energy absorbed means energy transferred from the radiator to the absorber, that is, work done by the one upon the other through the intervening medium, and done because of the motion of the absórber relative to the wave front. But to get work done, with motion as one of the essentials, there must be resistance to this motion. Denoting by p the resisting force per unit area at right angles to x, we have $qle=qpl$, and therefore $p=e$. When the radiator and absorber keep a fixed distance apart, $l=vt$, in which v is the velocity of the radiation and t the time of action. Substituting, we have $qvte=qvpt$, or again $p=e$.

This law of radiation was deduced theoretically first by Maxwell[6], and later in a different manner by Bartolli[7]. Subsequently it was proved experimentally by Lebedew[8] and by Nichols and Hull[9].

Assuming equality between action and reaction it appears that the pressure on the radiator must be the same as that on the complete absorber, but in the opposite direction.

Let the absorber be replaced by an optically plane perfect reflector at right angles to x and kept at a fixed distance from the radiator. The perfect reflector, since it stops the radiation in one direction and returns an exactly equal radiation in the opposite, may be regarded as, first, a perfect absorber for the incident radiation, from which action there results $p_a = e$, where p_a is the pressure due to absorption, and, second, an equal pressure in the same direction due to its reradiating (reflecting) the incident energy. Hence $p_a + p_r = 2e$, in the case of the perfect reflector. Partially reflecting opaque objects suffer pressures intermediate between e and $2e$.

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[6] Treatise on Electricity and Magnetism (1st Edition), II, 391, 1873.

[7] Nuovo Cimento, 15, 193, 1884.

[8] Rapports, Congrès International de Physique, 2, 133, Paris, 1900.

433, 1901. [9] Phys. Rev. 13, 293, 1901: Proc. Am. Acad. 38,55 9, 1903.

A perfectly transparent object of course suffers zero pressure.

When a region is filled with perfectly diffused radiation, that is radiation equally intense in all directions, the pressure can be determined by considering its action on an enclosing cube with perfectly reflecting unit sides. Let all the radiation pressure be resolved parallel to the sides of the cube, which of course may have any orientation whatever. The result will be as though the radiation itself could be and were so resolved. Since the radiation is perfectly diffused at first, then, supposing that it can be and is resolved, one-sixth of it will be moving perpendicularly towards each side. As above seen the pressure on a perfect reflector at right angles to the path of radiation is $2e$, where e is the energy per unit volume of this unidirectional radiation. If, then, D is the total energy of the perfectly diffused radiation per unit volume, its pressure in all directions upon perfectly reflecting waves is $2\frac{D}{6}=\frac{1}{3}D$, and this will be the pressure on the walls of any enclosing vessel that remains filled with uniformly diffused radiation, whether wholly or partially by reflection or radiation, since that means a certain action (pressure) due to absorption (arrest), and an equal reaction (pressure in the same direction) due to equal and opposite reradiation or reflection of the same or equivalent radiation.

PERFECTLY DIFFUSED RADIATION, HOW TO SECURE.

Any space completely enclosed by adiathermanous walls at uniform temperature must be filled with perfectly diffused radiation. That is, radiation that is everywhere equal in intensity, kind, and direction. If not so filled then the radiation must be unequally dense in different places so that an absorber of this radiation at the same temperature as the walls will grow warmer in one position and colder in another. In either case a body at one temperature will grow warmer by gain of heat from one at a lower temperature, a result contrary to the second law of thermodynamics. A similar argument would apply if the radiation was polarized. Hence we conclude that withinany such inclosure radiation is nonpolarized and perfectly diffused, no matter what the nature of the enclosing adiathermanous constant temperature walls nor what the nature and number of enclosed objects.

Such an enclosure constitutes a perfectly black body, since all radiations within it are completely absorbed, that is, none can get out, and it also constitutes a full radiator. Lamp black, platinum black, and a few other substances radiate and absorb approximately as ideal black bodies or full radiators.

COSINE LAW.

By observation and by experiment we know that radiation moves in straight lines, from which it follows that the intensity from point sources varies inversely as the square of the distance to the radiator. Now let an object, a small sphere say, be surrounded by constant temperature adiathermanous walls and let one of these be flat and near the sphere. Then, since the radiation is perfectly diffused, any solid angle drawn from the center of the sphere will receive from the intercepted wall the same amount of radiation as does any other equal solid angle from this point. Consider then two such solid angles, or cones, equal in size, but very small, drawn so as to intercept the flat part of the wall at different distances from the sphere. These cones will contain radiation equally intense, but from unequal areas. Let the area intercepted on the plane by a small cone whose solid angle is ω be A, its distance from the sphere r, and the angle between the axis of the cone and the normal to the plane at the point of intersection of the axis and plane θ, then $A=\frac{\omega r^2}{\cos\theta}$. Let a be the radius of the small sphere, and e the radiation normal from a unit area of the flat surface, and $e\psi(\theta)$ its radiation at an angle θ from the perpendicular, then the radiation received by the small sphere within the minute solid angle ω is

$$R=\frac{\omega r^2}{\cos\theta}e\psi(\theta)\frac{1}{r^2}a^2\omega=a^2\omega^2\frac{e\psi(\theta)}{\cos\theta}.$$

($\psi(\theta)$ assumed constant throughout ω. But R is a constant, and therefore, since a and ω are constants, $\psi(\theta)$ must change as $\cos\theta$, and also be equal to it when $\theta=0$. Therefore $\psi(\theta)=\cos\theta$, or the intensity of the radiation of the full radiatorin any direction is proportional to the cosine of the angle between this direction and the normal to the radiating surface. In the case of objects that are not full radiators the same law applies approximately, since the color and brilliancy of objects remain substantially the same no matter at what angle they are viewed.

TOTAL RADIATION FROM A FULL RADIATING SURFACE.

Let $e_\lambda d\lambda$ be the radiation per second between λ and $\lambda+d\lambda$ normal to the radiating surface and from a unit area. Then with θ the angle between the direction of radiation and the normal we have for the total of this radiation per second from a surface S

$$R_\lambda=2\pi e_\lambda d\lambda S\int_0^{\frac{\pi}{2}}\cos\theta\sin\theta d\theta=\pi e_\lambda d\lambda S,$$

or $\pi e_\lambda d\lambda$ per unit flat area. This value differs with different wave lengths. Hence for total radiation per second per unit flat area we have

$$R = \pi \int_0^\infty e_\lambda d\lambda.$$

This changes from object to object, and varies with the temperature.

By definition the absolute emissive power of any given surface is its *total* radiation when at 1° C. absolute.

STEWART-KIRCHHOFF LAW.

Consider a unit flat surface S of any material surrounded by nondiathermanous walls at the same temperature as the enclosed object. As just seen the total radiation per second of this surface, if black, is

$$R = \pi S \int_0^\infty e_\lambda d\lambda,$$

and this is also equal to the total simultaneous incident radiation H, which, since the surface is black, is the same as its absorption.

If, however, the surface S is not black then it will absorb only A units of the total, H, incident, and during the same time emit E units. But as the temperature remains constant we have $E = A$. But $R = H$,

$$\text{hence } E = \frac{A}{H} R,$$

$$\text{or } \left(\frac{E}{\frac{A}{H}}\right)_T = (R)_T.$$

That is, the ratio of the emissivity of any object to its coefficient of absorption (energy absorbed divided by energy incident) depends upon its temperature only; and numerically is equal to the emissivity of the full radiator at the same temperature.

When the object is not black the energy a absorbed in a given beam increases, as we know by experiment, as the angle of incidence decreases, and hence, as can easily be demonstrated, the corresponding value of e increases in the same proportion under the same circumstances; or, when both apply to the same angle, $e_\theta = a_\theta$ for all angles.

By the aid of an inclosing screen, perfectly reflecting to all wave lengths except one and fully transparent to this, the interchange of energy between S and the outer shell can be restricted to a single wave lengh λ, but still the temperature must remain constant, since otherwise an object at one temperature would be able to heat another at a higher, a result contrary to all experience. Therefore the

radiation A_λ, absorbed, must equal the radiation E_λ, emitted, and

$$\left(\frac{\frac{E}{A}}{H}\right)_{\lambda,T} = (R)_{\lambda,T}.$$

By the introduction of a polarizer in the path of the energy the radiations exchanged can be restricted to any particular azimuth Φ of polarization, so that we can more definitely write

$$\left(\frac{\frac{E}{A}}{H}\right)_{\lambda,\Phi,T} = (R)_{\lambda,\Phi,T}.$$

INTENSITY OF RADIATION A FUNCTION OF REFRACTIVE INDEX OF ADJACENT MEDIUM.

Let single wave-length radiation have its origin at 0_2, fig. 1, in a medium whose refractive index for this radiation is μ_2. Let this radiation, filling an infinitesimal solid angle, pass across the interface AB into a medium of refractive index μ_1, and let μ_2 be greater than μ_1.

The radiation that actually comes from 0_2 will, to an observer in the outer medium, appear to have its origin at 0_1, and therefore $\frac{0_2D}{0_1D} = \frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}$. Also, if ω_2 is the small solid angle at 0_2, and ω_1 the corresponding solid angle at 0_1, $\frac{\omega_2}{\omega_1} = \frac{0_1D^2}{0_2D^2} = \left(\frac{\mu_1}{\mu_2}\right)^2$. Consequently, if R_1 and R_2 represent the energy flux in unit solid angles from 0_1 and from 0_2, respectively, then $\frac{R_1}{R_2} = \frac{\omega_2}{\omega_1} = \left(\frac{\mu_1}{\mu_2}\right)^2$. This of course holds for every direction from 0_2 and therefore for the whole space solid angle 4π. That is, the total radiation of this wave length is directly proportional to the square of the refractive index of the surrounding medium. This assumes no reflection at the interface AB, and therefore is not a rigidly correct assumption even when the cone of radiation is infinitesimal in size. However, if the medium of refractive index μ_2 is limited and completely surrounded by the medium of index μ_1, then evidently the law that holds for the incident light holds also for any that is reflected, and on summing up the incident and the reflected portions the relation clearly will be just what it would be with no reflection, that is, $\frac{R_1}{R_2} = \left(\frac{\mu_1}{\mu_2}\right)^2$. Or, conceivably, the refractive index might change gradu-

ally from μ_2 to μ_1, in which case there would be no reflection to consider.[10]

Obviously the argument is quite similar and the conclusion the same when the radiation has its origin in the medium of smaller index.

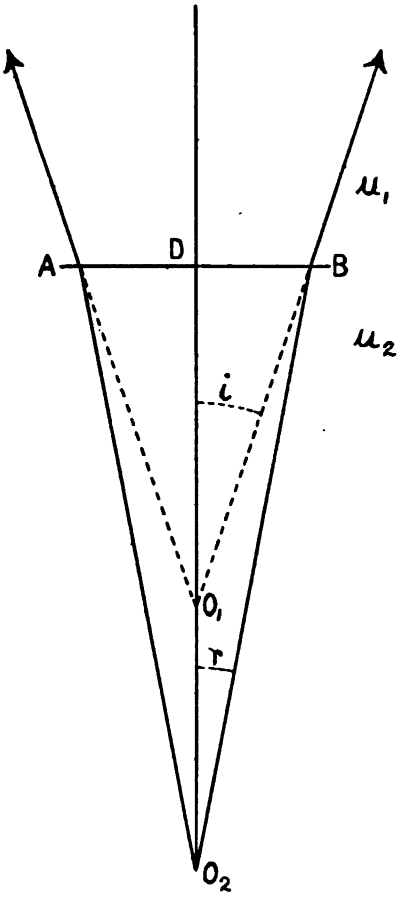

FIG. 1.

According to this law a high barometer, because of the resulting increase of the refractive index of the atmosphere, as well as because of its usually accompanying clearness and transparency, facilitates radiation from all objects on the surface of the earth. On the other hand, owing to the Ångström pressure effect, a high barometer causes

[10] To any one not satisfied with this proof, the more elaborate and perfectly rigid demonstration given in Drude's Optics is recommended.

an increase in absorption. The final result therefore is due to a variety of unequal and in some cases even conflicting causes, and possibly in part to causes as yet even wholly unknown.

In the case of dry air at normal pressure and zero temperature, we get for violet light $\mu = 1.0003$ approximately, and of course a slightly smaller number for the long wave earth radiations. When the barometer reads p atmospheres we have $\mu_p = 1 + p\,(.0003)$.

A little calculation will show that our greatest changes in the barometer, so far as mere change in the refractive index is concerned, can increase a 20° C. fall in temperature by not more than one one-thousandth of a degree, an amount meteorologically negligible.

RELATION OF TOTAL RADIATION OF A BLACK BODY TO ITS TEMPERATURE.

This relation was first determined empirically by Stefan[11] from the experiments of others, and later deduced by Boltzmann[12] from thermodynamic considerations similar to those used by Bartolli in his work on radiation pressure.

The problem can be definitely stated as follows: Let $F(T)$ be the radiant energy per unit volume in a space surrounded by a black body shell at the absolute temperature T, and $f(T)$ the corresponding radiation pressure: Required to find the value of $F(T)$ in terms of T. As shown under the caption *light pressure*,

$$f(T) = \tfrac{1}{3} F(T). \text{ Hence } Tf(T) = \tfrac{1}{3} TF(T), \text{ or, briefly, } Tf = \tfrac{1}{3} TF, \ldots. (1)$$

$$\text{and, } Tdf + fdT = \tfrac{1}{3} FdT + \tfrac{1}{3} TdF.$$

But $Tdf - fdT = FdT \ldots\ldots\ldots\ldots (2)$. See Boltzmann[13].

$$\text{Therefore, } 2Tdf = \tfrac{4}{3} FdT + \tfrac{1}{3} TdF \ldots\ldots\ldots (3)$$

From 1, with T constant, we get

$$Tdf = \tfrac{1}{3} TdF,$$

which, when substituted in 2 so as to eliminate df, gives

$$\tfrac{1}{3} TdF = \tfrac{4}{3} FdT, \text{ or } \frac{dF}{F} = 4\frac{dT}{T}.$$

$$\text{Therefore, } \log. F = 4 \log. T + \log. C, \text{ or } F(T) = CT^4.$$

Equation 2 does not admit of easy proof and therefore slightly modified derivations of this law have been used. The following, adopted from Wood's Physical Optics, is one of the best.

Let $D = F(T)$, be the perfectly diffused radiation energy per unit volume, and $p = f(T)$ the radiation pressure per unit area, each at

[11] Wien. Akad. Ber. 79, p. 391, 1879.

[12] Wied. Ann., 22, p. 291, 1884.

[13] l.c.

temperature T. Let the original volume and temperature be V_0 and T_0, respectively, and let there be adiabatic expansion from V_0 to V, giving new values of D and p, corresponding to temperature T. As the expansion is adiabatic the entropy remains constant.

$$\text{Therefore, } \frac{V(D+p)}{T} = C,$$

$$\text{and } (D+p)\,dV + V d(D+p) = \frac{V(D+p)}{T}\,dT.$$

$$\text{Also } d(VD) = -p\,dV, \text{ because of adiabatic expansion,}$$
$$\text{or } D\,dV + V\,dD = -p\,dV.$$

$$\text{Therefore, by substitution, } V dp = \frac{V(D+p)}{T}\,dT,$$

$$\text{or } T dp = (D+p)\,dT.$$

$$\text{But } D = F(T), \text{ and } p = f(T) = \tfrac{1}{3}F(T).$$

$$\text{Therefore, } \tfrac{1}{3}T dF(T) = [F(T) + \tfrac{1}{3}F(T)]\,dT = \tfrac{4}{3}F(T)\,dT,$$

$$\text{or } \frac{dF(T)}{F(T)} = 4\frac{dT}{T}.$$

$$\text{Therefore, } \log. F(T) = 4 \log. T + \log. C, \text{ or } F(T) = CT^4.$$

This is known as the Stefan-Boltzmann law and shows that a black body gives out energy by radiation at a rate proportional to the fourth power of its absolute temperature. An imperfect radiator, even when losing energy by virtue of its hotness only, that is, when simply incandescent, radiates according to some power of its temperature other than the fourth, but one that can not at present be calculated, nor is it easy to determine experimentally.

One of the most carefully studied radiators is polished platinum, which from 400°C. to 1,600°C. gives off total radiation at a rate approximately proportional to T^5.

It must not be supposed, however, that platinum, or anything else for that matter, radiates more at any given temperature than does the black body whose temperature exponent is only 4. In fact they all radiate less owing to the smaller value of their temperature coefficients. Thus in the case of platinum, for instance, if R_p is its total radiation at temperature T, and R_b the total radiation of the black body at the same temperature, then $R_b = CT^4$, and $R_p = KT^5$ approximately, but $R_b > R_p$, both by theory and by observation, and, thereforo, $C > KT$.

GRAY BODY.

By definition a gray body is one the intensity of whose every wave length bears a constant ratio, less than unity, to the intensity of the same wave length of the full radiator at the same temperature. Quali-

tatively their spectra are the same, but quantitively every where different in a constant ratio. No such body has been found in nature, nor can it by any known process be artificially realized, as can the black body, except approximately. Its interest, therefore, is in certain theoretical discussions.

RELATION OF THE SPECTRUM OF A BLACK BODY TO ITS TEMPERATURE.

We know by ordinary experience that when any substance, charcoal, for instance, that approaches the black body in its nature is gradually heated it is first distinctly visible as a red object, and then as a more decidedly white one as the temperature rises. Careful bolometric examination of its spectrum shows an increase in the radiant energy of every wave length, as the temperature rises, and a corresponding shifting of the maximum from the longer to shorter wave lengths.

The exact relation of the spectrum of a full radiator to its temperature has been theoretically and most ingeniously determined by Wien[14] with the aid of a conception analogous to that used first by Bartolli in the study of radiation pressure and later by Boltzmann in establishing the Stefan-Boltzmann law. This method, abbreviated and simplified, will be followed here.

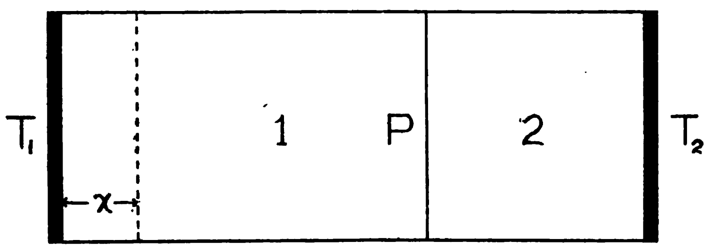

FIG. 2.

Let the ends of a cylinder, fig. 2, of unit cross section, be faced with full radiators at the constant absolute temperatures T_1 and T_2, and let T_2 be greater than T_1.

Let the walls of the cylinder be perfect reflectors, and let it be divided into two compartments, 1 and 2, by the perfectly reflecting partition P, parallel to the ends. The energy density, $F(T_2)$, in compartment 2 will be greater than the corresponding density, $F(T_1)$, in compartment 1. Now replace the radiator at temperature T_1 by a perfect reflector and let it be pushed toward P a distance b, such that

[14] Wied, Ann. 52, p. 132, 1894.

the energy density in the shortened compartment 1 is equal to that in 2. Suppose that the distribution of energy in the spectrum is different in the two compartments, though the energy density is the same. Let energy of wave length λ be denser in 2 than in 1; make P transparent to λ only. Energy will flow from 2 to 1, and at the same time an equal amount of radiant energy of wave length λ will flow into 2 from the radiator at temperature T_2. The energy density now is greater in 1 than in 2, and therefore, on making P a perfect reflector for all radiant energy, chamber 1 is capable, by driving its reflecting end out a distance b, to its original position, and at the same time reducing its energy density to $F(T_1)$, to do not only the work formerly done by compression, but also an additional amount equal to the energy transmitted through P while transparent to λ. On replacing the reflecting end by the black body at temperature T_1 everything will be in its original condition, and all the radiant energy drawn from a thermal source will have been converted into work through a cyclic process, a result contrary to the second law of thermodynamics. Consequently, when the energy density is the same, the energy spectrum is also the same.

Evidently, then, though the spectral distribution of the energy given off by a full radiator changes with change of temperature, the spectra of any two such radiators at different temperatures can be made identical by making their energy densities the same.

Let us see, then, how this is possible—how it is brought about.

As above explained, the energy density in chamber 1 was made equal to that in chamber 2 by compression between perfectly reflecting walls. Let the original length of chamber 1 be a and its final length $a-b$. Since the walls of the chamber are perfect reflectors every incident wave is reflected, and therefore the number of waves filling the space is the same after as before compression. Or if λ_0 is the wave length before, and λ the wave length after compression (shortened by the Doppler effect as the reflecting end is moved in), while V_0 and V are the corresponding volumes, then

$$\frac{\lambda^3}{\lambda_0^3}=\frac{V}{V_0}$$

But since the cross section is constant, unity in this case,

$$\frac{V}{V_0}=\frac{a-b}{a}$$

$$\text{Therefore, } \lambda=\left(\frac{a-b}{a}\right)^{\frac{1}{3}}\lambda_0$$

Let Q be the total energy in chamber 1 after compression through a distance x, giving an energy density corresponding to a temperature T, where $T_2 > T > T_1$, then

$$F(T) = \frac{Q}{a-x},$$

$$\text{and } \frac{dF(T)}{dx}\,dx = \left[\frac{dQ}{dx} + F(T)\right]\frac{dx}{a-x}.$$

But the pressure $= \frac{1}{3}F(T) = \frac{dQ}{dx}$.

Therefore, $$dF(T) = \frac{4}{3}F(T)\frac{dx}{a-x},$$

$$\text{or } \frac{dF(T)}{F(T)} = \frac{4}{3}\,\frac{dx}{a-x},$$

$$\text{and } \int_{T_1}^{T_2}\frac{dF(T)}{F(T)} = \frac{4}{3}\int_0^b \frac{dx}{a-x},$$

$$\text{or } \log\frac{F(T_2)}{F(T_1)} = \frac{4}{3}\log\frac{a}{a-b}.$$

Therefore, $$\frac{F(T_2)}{F(T_1)} = \left(\frac{a}{a-b}\right)^{\frac{4}{3}}.$$

But if λ before compression, and corresponding to T_1, is λ_1, while after compression to correspond to T_2, it is λ_2, then, as seen above,

$$\left(\frac{\lambda_1}{\lambda_2}\right)^4 = \left(\frac{a}{a-b}\right)^{\frac{4}{3}}.$$

Hence $$\frac{F(T_2)}{F(T_1)} = \frac{\lambda_1^4}{\lambda_2^4}.$$

But, as we know from the Stefan-Boltzmann law, $F(T) = CT^4$.

Therefore, $$\frac{T_2}{T_1} = \frac{\lambda_1}{\lambda_2},$$

or $T\lambda =$ a constant. That is, the wave length of any given point on the energy curve is inversely proportional to the absolute temperature; so that if we know the intensity distribution for black body radiation at any temperature whatever, we can calculate it for all others.

Probably that point in the black body spectrum which can be determined with greatest precision is the place of maximum radiation. Calling this λ_m, we have $\lambda_m T =$ a constant.

The value of λ_m for the ideal black body is known very closely for a considerable range of temperatures, and the observed results agree excellently with those calculated according to the above equation.

By the use of this equation it becomes at once possible, through the aid of bolometric curves, to calculate the effective (or black body) temperature of the sun, which probably is not far removed from its actual surface temperature.

Suppose the value of λ_m for the sun (λ for the crest of the bolometric curve when corrected for absorption, etc.) is one-fifth, say, of λ_m for a black body at 1,200°C. Then since $\lambda_m T$ is a constant, we have the temperature of the sun as five times that of the black body, or 6,000°C.

Since, as we have seen, the wave length λ corresponding to any definite point, such as that of maximum radiation, on the spectrum energy curve of the black body is so related to the absolute temperature that $\lambda T =$ a constant, therefore,

$$\frac{\lambda_2-\lambda_1}{\lambda'_2-\lambda'_1}=\frac{\delta\lambda}{\delta\lambda'}=\frac{T'}{T},$$

or $\delta\lambda T^{-1}=$ a constant.

Further, in the process of wave shortening, (movement of the reflecting end of the cylinder), all the energy belonging to the old wave lengths λ_1 to λ_2, and no more, is limited to the corresponding new region λ'_1 to λ'_2. Now let the spectrum energy curve be drawn with λ for the abscissae and $\varphi(\lambda)$ for the ordinates, and let the total radiant energy of all wave lengths, be $E=CT^4$, and that part lying between λ_1 and λ_2, $\frac{E}{n}$.

$$\text{Then } \varphi(\lambda)\delta\lambda=\frac{E}{n}=\frac{CT^4}{n},$$

$$\text{and } \varphi(\lambda')\delta\lambda'=\frac{E'}{n}=\frac{CT'^4}{n},$$

$$\text{Therefore, } \frac{\varphi(\lambda)}{\varphi(\lambda')}=\frac{T^4\delta\lambda'}{T'^4\delta\lambda}=\frac{T^5}{T'^5}.$$

That is, with wave lengths as the abscissae, the ordinate of any given point on the black body energy curve is proportional to the fifth power of the absolute temperature.

The point of maximum energy is definitely determinable, and, calling the ordinate of this point $\varphi(\lambda)_m$, we get $\varphi(\lambda)_m T^{-5}=$ a constant.

Evidently this, too, furnishes a means for determining the temperature of one full radiator in terms of that of another.

COMPLETE RADIATION EQUATION.

Several attempts have been made to find an equation that gives the distribution of energy in the spectrum of a black body at any temper-

ature, but some, at least, of the assumptions and methods of procedure appear open to criticism and therefore it probably is not desirable to reproduce them here.

From electromagnetic considerations Planck[15] obtained the following equation

$$E = C_1 \frac{\lambda^{-5}}{e^{\frac{C_2}{\lambda T}} - 1},$$

in which C_1 and C_2 are constants, T the absolute temperature, and E the radiation intensity, or $Ed\lambda$ the energy belonging to the region between λ and $\lambda + d\lambda$, and e the Napierian base.

While perhaps not incontestably correct, like the Stewart-Kirchhoff, the Stefan-Boltzmann, and certain other radiation and absorption laws, this probably is the best of the general, or complete radiation equations so far derived, and agrees almost exactly with the observations from 85° C. to 1773° C. by Rubens and Kurlbaum[16].

If the energy spectrum curve is so drawn that the abscissae are proportional to the corresponding wave lengths then, instead of E in the above equation, we can write the ordinate $\varphi(\lambda)$ of the point λ, or some multiple of it.

SUMMARY.

The following are the principal laws of radiation and absorption.

1. *Prevost's theory of exchanges:* In the case of black bodies

$$G = KC(T_1^4 - T_2^4),$$

in which G is the energy gain per second by the black body at the absolute temperature T_2 from some other black body at absolute temperature T_1, C the absolute emissive power of a unit area of black surface, or its total radiation per unit time when at the absolute temperature 1° C., and K a constant depending upon the distance between the two objects and their sizes. If the distance between the two objects is r centimeters, and their cross sections at right angles to r, A and A' square centimeters, respectively, then

$$K = \frac{AA'}{r^2}.$$

Also, with one square centimeter for the unit area

$$C = 5.32 \times 10^{-5} \text{ ergs per second, or } 5.32 \times 10^{-12} \text{ watts.}$$

Therefore, $G = \frac{AA'}{r^2} 5.32 \times 10^{-5} (T_1^4 - T_2^4) \frac{\text{ergs}}{\text{second}}.$

[15] Ann. der. Phys., 4, 553, 1901.

[16] Ann. der. Phys. 4, 649, 1901.

2. *Bouguer's law of absorption:*

$$I_m = I_0 a^m,$$

in which I_0 is the intensity of the incident radiation, a the coefficient of transmission, or the ratio of the radiation that gets through a layer of unit thickness of the absorbing medium to the incident radiation, m the thickness of the absorbing medium traversed, and I_m the radiation that gets through the layer of thickness m.

This law holds rigidly only for single wave-length radiation.

3. *Light pressure:*

$$p = e,$$

in which p is the pressure on a unit black area at right angles to the line of propagation, and e the energy per unit volume of this unidirectional radiation. When the receiving surface is a perfect reflector $p = 2e$.

In the case of full sunshine just outside the earth's atmosphere, p per square centimeter is of the order 4×10^{-8} gramme.

In this connection it may be worth while to call attention to the inconceivably minute minimum amount of energy to which the eye will respond. Taking the faintest stars that are visible to the unaided eye, it can be shown that the light energy of one of these that reaches the retina is so small that it would heat a gramme of water 1° C. in not less than 100,000,000 years, and yet the eye responds to it at once, for the instant we look we see.

4. *Cosine law:*

$$R_\theta = R_n \cos \theta,$$

in which R_n is the radiation per unit area normal to the full radiator, or black surface, and R_θ its radiation in a direction θ degrees from the normal. The solid angle filled by the radiation being the same in the two directions.

5. *Stewart-Kirchhoff law:*

$$\left(\frac{\frac{E}{A}}{H} = R\right)_T$$

in which E is the radiation per unit area of any object, H the radiant energy incident upon this area, A the energy it absorbs, and R the radiation of an equal black body surface—all at the same temperature, T, and confined to the same spectral region, which, however, may be anything from single wave-length to complete radiation.

The ratio of the emissivity of any object to its coefficient of absorption (energy absorbed divided by energy incident) depends upon its temperature only; and numerically is equal to the emissivity of the full radiator at the same temperature; all confined to the same spectral region of any range.

6. *Dependence of radiation upon refractive index of adjacent medium:*

$$\frac{R_1}{R_2} = \left(\frac{\mu_1}{\mu_2}\right)^2.$$

R_1 and R_2, respectively, are the radiations of equal black body areas at the same temperature in media whose refractive indices are μ_1 and μ_2.

7. *Stefan–Boltzmann law:*

$$R = CT^4.$$

R is the complete radiation per unit black body area at the absolute temperature T, while $C = 5.32 \times 10^{-5}$ ergs per second per square centimeter.

8. *Wien's displacement law:*

$$\lambda T = \text{a constant},$$

in which λ is the wave length corresponding to any given point on the radiation energy curve, and T is the absolute temperature. As a special case $\lambda_m T = A$, where λ_m is the wave length of maximum intensity. If λ is written in thousandths of a millimeter, or microns, then $A = 2940$ (Lummer), or 2921 (Paschen).

9. *Ordinate temperature relation in the normal (abscissae proportional to wave lengths) energy curve:*

$$\varphi(\lambda)\, T^{-5} = \text{a constant}.$$

Here $\varphi(\lambda)$ is the ordinate corresponding to a given point on the energy curve. A special and important case is $\varphi(\lambda)_m T^{-5} =$ a constant, in which $\varphi(\lambda)_m$ is the ordinate (maximum), corresponding to the wave length, λ_m, of maximum intensity.

Instead of $\varphi(\lambda)_m T^{-5} =$ a constant, we can write $E_m T^{-5} = B$, in which E_m is the energy lying between λ_m and $\lambda_m + d\lambda$. This is too small to be determined accurately, and therefore any arbitrary numerical value may be assigned to it.

Assuming $E_m = 1{,}000$ when $T = 1{,}000°$ C., then $B = 10^{-12}$.

10. *General radiation equation:*

$$E = C_1 \frac{\lambda^{-5}}{e^{\frac{C_2}{\lambda T}} - 1}$$

in which E is the radiation intensity belonging to the spectral region λ, e the Napierian base, $C_2 = 4.965\ \lambda_m T = 14{,}500$ (Paschen); 14,600 (Lummer), and $C_1 = 3.073 \times 10^7$, on the assumption that $E_m = 1{,}000$ when the absolute temperature $T = 1{,}000°$ C.

11. *Type of absorption independent of temperature:*

So long as its physical phase and its chemical composition remain unchanged a body continues to absorb the same wave length radiation, independent of change of temperature. This is of universal application, so far as known, and not restricted to black bodies.

12. *Increase of radiation with increase of temperature:*

Every wave length radiation that an object emits increases in intensity with increase of temperature so long as its physical phase and chemical composition are unaltered. This, too, so far as we know, is of universal application.

13. *Increase of absorption, by gases, with increase of pressure:*

The coefficient of absorption of many gases (all that have been examined) increases with increase of pressure, and this increase, while different for different gases, and most pronounced at pressures below one atmosphere, is the same in every particular whether the given increase in pressure is due to compression of the absorbing gas or to the addition of an inert one.

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AN UNUSUAL DISPLAY OF FALSE CIRRUS.

By W. J. Humphreys.

On the afternoon of May 27, 1909, there appeared to the north of Washington, D. C., such an unusual display of false cirrus as to justify a description of it, although the general phenomenon is one with which many people are familiar enough.

About 4:45 o'clock the writer noticed excellent examples of cumulus clouds in an otherwise clear sky to the north, from the Central Office of the U. S. Weather Bureau. They reached considerable elevations, as usual, and slowly drifted eastward, while others successively rose not far, seemingly, each from the seat of formation of the one that had just preceded; the whole merging into a continuous mass of cumulus with, for a time at least, more or less well-defined independent heads.

As each head reached a certain elevation, apparently the same in all cases, and continued to rise, a faint, wispy cloud that rapidly became denser, more extensive and well arched, began to form distinctly above it, with no visible connection between the two. With a still greater rise the cumulus head seemed to pierce the arched canopy, and to leave it, the false cirrus, floating distinctly below the highest points reached. In one instance the veil-like cloud caps of three different cumuli merged into a continuous wavy or billowy wisp, that rose and fell as it passed from one cloud mass to another.

As above stated the sky in the region of the cumuli was clear, but to the south of the observer's zenith, when first noticed, was a thin layer of cirro-stratus that extended a considerable distance in that direction, but how far is not certain for its southerly limit was not observed. This thin cloud slowly extended north, and after a time reached the place where the cumuli were rising. The cirro-stratus was then thrown into arches over the rising thunder heads, and at these places became denser than elsewhere, and showed all the characteristics of the false cirrus that had formed at the same elevation over similar heads that had previously risen into a clear sky.

A rising mass of air, with or without a cumulus cloud, must send somewhat ahead of itself, practically as a rising solid does, a disturbance in the form of a vertical and a horizontal flow. The vertical component, of course, leads to dynamical cooling, and if at all pronounced will carry aloft any cloud particles that may be formed. And cloud

particles will be formed by this slight cooling (the change in elevation is not great) when, but only when, there is actual or very approximate saturation before the disturbance begins. This explains the action, above described, of the rising thunder heads on the overlying thin cirro-stratus clouds, and the formation of denser cloud masses in their midst.

Evidently the region of the cirro-stratus clouds observed did not mark the limit of the relatively moist layer of atmosphere in which they were formed. It clearly extended some distance beyond them in the direction along which they were spreading. How far, it is impossible to say, but surely to the region of the cumulus clouds, at least 15 miles away when first noticed, since the false cirrus continued to form over each succeeding thunder head, and at the same elevation, from the one first observed till the whole region of the cumuli was covered by the cirro-stratus, the only difference being a much denser cloud formation on the arrival of the cirro-stratus.

This explanation of the formation of the false cirrus presumably has been very generally accepted, at least since the appearance of de Quervain's[1] paper on this subject, but the writer has never before seen such an excellent proof of it.

In each of the false cirri was repeatedly seen a phenomenon that appeared like a sudden condensation—a flashing out of denser cloud, or at times like the play back and forth of a great search light. It appeared to be perfectly white and was nowhere perceptible except in the false cirri. This observation was confirmed by Professor Marvin and others of the U. S. Weather Bureau who kindly observed it with me. While it had no appearance of lightning, with which any of us were familiar, other than the suddenness with which it came, it is practically certain that it was due to illumination by electric discharges in the cumulus clouds below. This conclusion is based on the following facts:

(*a*) As soon as it became dusk frequent sheet lightning was noticed in the heads of this general mass of cumulus clouds.

(*b*) At the time this phenomenon was being observed a severe thunderstorm passed some 15 to 20 miles to the north and northeast of Washington, presumably in the region of these clouds.

(*c*) No other explanation, such as sudden condensation, sudden crystalization and the like, seems remotely plausible.

The following appear to be reasonable conclusions to be drawn from the phenomena observed:

[1] Meteorologische Zeitschrift, Vol. 25, p. 440, 1908.

1. The top of the cumulus cloud is the real top of the rising moist atmosphere, as there is no condensation between it (and air passing through it would be saturated) and the false cirrus above.

2. This rising air and cloud mass send a disturbance to some distance ahead that causes an upward and outward (followed, probably, by an outward and downward) flow of the air.

3. The upward component of this disturbance when applied to a nearby saturated layer of air, and only then, for it does not rise high, leads to the formation of the false cirrus.

4. A cloud region, such as a layer of cirro-stratus, may mark only a portion of a moist sheet of air. The extent of the latter may greatly exceed that of the former.

5. Electric discharges may, and probably often do, take place high up in a cumulus cloud without being visible by day in the cloud itself.

THE AEROLOGICAL CONGRESS AT MONACO.

By Prof. A. Lawrence Rotch.

The international study of aerology, as the exploration of the atmosphere is now called, was begun by a small commission, including the writer as the American member, which was appointed at an International Meteorological Congress held at Paris in 1896. Although the commission bears the title "International Commission for Scientific Aeronautics," aeronautics serves only as the means of obtaining meteorological data in the free air. The work of the commission rapidly extended and five meetings were held in European cities before the session this year, which, by invitation of its honorary member, Albert I, Prince of Monaco, occurred during the first week of April in the new Oceanographic Museum at Monaco. The interest and importance of this, the sixth reunion, served to bring together about thirty colleagues from fourteen nations, the writer representing the United States Weather Bureau, besides his own observatory at Blue Hill, where the first aerological observations in America were undertaken[1].

The conference was opened on April 1 by Professor Hergesell of Strassburg, president of the commission, who reviewed the progress made in exploring the air since the meeting at Milan three years ago, dwelling particularly on the extensive cooperation during the simultaneous series in July, 1908, when balloons and kites were sent up from forty-four stations on land and sea, in both hemispheres. He emphasized the importance of determining the direction of the wind at different heights by observing pilot-balloons with theodolites. The Prince of Monaco welcomed his guests to the new Oceanographic Museum, which he hopes may become a repository for the results of soundings of the air, as well as of the sea, and to his yacht *Princesse Alice*, which has been used in marine and atmospheric soundings from the equator to beyond the Arctic Circle. In this connection The Prince described the launching and recovery of a ballon-sonde at sea.

At the business meeting which followed Professor Hildebrandsson of Upsala was named vice president of the conference. The death of

[1] These first observations with kites were made in 1885 by Mr. A. G. McAdie of the U. S. Signal Service (now professor of meteorology, U. S. Weather Bureau) who was then studying atmospheric electricity under Prof. John Trowbridge of Harvard University. See Monthly Weather Review, December, 1904, p. 567-8.—Editor.

Professor Pernter of Vienna was announced and Professor Trabert, his successor as director of the Austrian Meteorological Office, was chosen a member of the commission. Other members elected were: M. Vincent, head of the Belgian Meteorological Service; Doctor Kleinschmidt, in charge of the Lake Constance Kite-station; Captain Ryder, director of the Danish Meteorological Institute; Professor Bjerknes of Christiania and Doctor Bamler of Essen, the directors of the observatories at Irkutsk, Tiflis, and Ekaterinburg, and four military aeronauts, Captains Voyer and Bouttieaux of France, Clément St. Marcq of Belgium, and Colonel Capper of Great Britain.

The programme for the meeting was intended to include:

1. Technical questions, relating to balloons and instruments.
2. Methods, organization, and equipment of stations and expeditions.
3. Reports of expeditions during the preceding year.
4. Other questions, including new projects.

The international commission on a system of world stations, a subcommission appointed by the international meteorological committee, also met in conjunction with the aeronautical commission.

In the first section of the programme Doctor Assmann, director of the Prussian Aeronautical Observatory, described a new process of making ballon-sondes by dipping in a rubber solution, instead of cementing sheets of rubber. The particles of dust in the latter cause the pores to open, but the dipped balloons expand 4 to 6 diameters without losing gas or bursting, permitting a greater height to be reached or a smaller balloon to be used. The parachute cords, by friction on the rubber, weaken it, or if two balloons are used, the smaller sets up oscillations which are injurious to the record, therefore Doctor Assmann would use two concentric balloons, one of which bursts on reaching its maximum altitude, causing the other to descend slowly. He now uses a rubber captive balloon of 14 to 17 cubic meters capacity, which loses no gas and therefore does not present pockets to the wind, and when carrying wire of 0.6 millimeter diameter can reach an altitude of 4,000 meters. To avoid the chemical effect of insolation on the rubber the upper portion of the net is covered with a yellow fabric.

A discussion followed as to the advantages of rubber and goldbeater's skin for captive balloons. In another paper Doctor Assmann described an instrumental method to ascertain whether the ventilation of thermometers is sufficient in the isothermal layer. While the upper inversion was shown as early as 1893 by the observations of Her-

mite and Besançon, yet, for a long time it was attributed to insolation. The source of error was later avoided by night ascensions and the descent of the balloon was accelerated by letting gas escape by clock-work. The rubber balloon has a nearly constant velocity of ascent which produces a ventilation that with the protection afforded by a bright metal casing is generally thought sufficient. It may be doubted whether the extremely rare air can carry off heat from the thermometric strip, but if there is no change when an artificial current reinforces the draught caused by the motion of the balloon then the instrumental error may be assumed to be *nil*. Compressed air contained in a globe of polished metal is liberated against the thermometric strip during ten minutes (by means of an aneroid barometer) at the height where the inversion of temperature usually begins in cyclonic or anticyclonic conditions. This device has not yet been tried in the high atmosphere. The second part of Doctor Assmann's paper described an apparatus for ventilating thermometers in captive balloons, especially during calm weather. A horizontal screw is driven by an electric battery and a dipping vane changes the direction of rotation when the descent begins.

In discussing the first subject the president asked to have it noted that, in spite of incredulity in some quarters regarding the reality of the great temperature inversion, no member of the commission doubted its existence.

Professor Hergesell exhibited a new meteorograph for manned and captive balloons having a bimetallic blade for the temperature and a Vidi box for pressure, with an automatic ventilator for the former. This instrument, made by Bosch of Strassburg, weighs 1,200 grams and costs $75. A discussion followed as to the use of a straight bimetallic blade instead of a curved one.

Professor Palazzo, director of the Italian Meteorological Office, described two devices for detaching ballons-sondes at sea, in which the Bourdon barometric tube at a predetermined altitude detaches one of the tandem balloons, or else liberates the gas. In discussing the necessity of limiting the time of the ascensions other devices for detaching the balloon were mentioned.

Professor Rotch urged the adoption of a uniform method of publishing the kite data and proposed the form used at Blue Hill and Mount Weather. He pointed out the confusion between the positive and negative sign attached to the temperature gradient in the official publication of kite and balloon observations. Following the report of a committee appointed to consider the matter, the conference de-

cided to call the gradient positive when the temperature decreased with altitude and negative when it increased with altitude and to give the simultaneous observation at the ground, as far as possible, in the published kite observations.

Professor Köppen, of Hamburg, sent a memoir in which he proposed that instead of the readings of the barometer, the data be expressed in absolute units of the C. G. S. system, and that the barometric readings be reduced to a height of 100 meters instead of to sea level. This proposition was referred to the international meteorological committee.

Professor Bjerknes, of Christiania, read a paper on the theoretical application of upper air observations, in which he pointed out that the object of aerological observations is to secure a diagnosis of the momentary dynamic condition of the atmosphere. A series of ascensions should give data separated by such intervals as will permit the changes occurring between different diagnoses to be followed, and through their combination enable laws to be formulated, whereby the future state of the atmosphere may be predicted. He proposed to adopt three diagnoses, namely, in the morning, at noon, and in the evening, or at 8, 1, and 7 o'clock Greenwich time, but as the instrumental equipment will not permit all the diagnoses to be complete, the one at 1 p. m. is declared the principal one. At this moment kites and balloons with instruments are to be sent up and observations made at the ground which will enable the atmospheric conditions at various levels to be completely charted. For the morning and evening diagnoses, besides the ground observations only pilot balloons need be sent up, but they should be sufficiently numerous to serve as a base for charts of air movements.

Professor Bjerknes endorsed Professor Köppen's proposition to use dynamical units to express atmospheric pressure and wind velocity, and in replying to questions as to the advantage of absolute measures he said that these avoid the introduction of constants in the application of the dynamic equations and thus give precision and simplicity. Tables facilitate the transformation of the old into the new units. Mr. Cave, of England, said that the upper air observations in England were now published in the Weekly Weather Report in absolute units.

Mr. Cave read a request from his colleague, Mr. Dines, that the ballons-sondes be sent up about an hour before sunset to avoid insolation and yet allow them to watched with a theodolite. Professor Rotch said that this practise had given good results in America, but the conference was unwilling to change the morning hour. It was later

voted that complete observations be obtained as nearly as possible at 7 a. m. Greenwich time, as heretofore, but that pilot balloons be sent up three times a day as desired by Professor Bjerknes during one of the shorter series of ascensions (in July, this year). There was also voted in this connection a proposition of M. Vincent, of Brussels, to observe the state of the sky on the international days.

M. Teisserenc de Bort, of Paris, spoke on the triangulation of ballons-sondes from 1898 to 1909 at Trappes and their importance for the verification of heights calculated by the barometer. The base line used was 1,300 meters, but there is now a base of 5,000 meters. While the two methods agree closely the effect of hysteresis in the barometer was evident, notwithstanding the small temperature correction. M. Teisserenc de Bort exhibited charts of the trajectories of his balloons, which showed that cyclonic rotation ceased at a certain height and was replaced by a calm zone that marks the top of the adiabatic temperature gradient. Above this the currents were from the south and west and opposed to the surface wind. In the Tropics superposed currents occur with a sudden change in direction at about 7,000 meters, the absence of cyclonic storms accounting for the stratification. As to the changes of wind in the "stratosphere," or region of the upper temperature inversion, M. Teisserenc de Bort had found only slight changes, but Messrs. Cave and Hergesell agreed that the velocity of the wind decreased there. Professor Hildebrandsson's observations of clouds confirm those of M. Teisserenc de Bort with balloons in showing a motion toward the north above 3,000 meters over a low-pressure area.

Continuing the technical questions, Professor Hergesell discussed the vertical velocity of rubber balloons as a function of their lift, and the use of pilot balloons to determine the horizontal and vertical currents of the atmosphere. In a closed space their velocity remains constant, so that, knowing the surface and free lift of a balloon its rate of ascent may be calculated, and there is little difference—about 4 per cent—between the heights obtained from angular observations at one station when combined with the assumed velocity, and heights determined from measurements at the ends of a base line. Successive observations enable the speed of the horizontal wind to be detertermined accurately. Sometimes the vertical currents may be observed by observations made at the angles of a triangular base, and in this way a downward movement of 1.5 meters per second has been measured. Captain Hildebrandt, of Berlin, said that on the Peak of Teneriffe pilot balloons were driven down for three minutes at the rate of

2.5 meters per second, and General Kowanko, of St. Petersburg, mentioned the fact that when above a sea of clouds aeronauts found currents rising over the cloud summits and descending in the spaces between the clouds.

M. Teisserenc de Bort discussed the facts relating to the great isothermal stratum. Up to about 10 kilometers the decrease of temperature is almost adiabatic; then in the next 5 kilometers there is usually a rise in temperature of 8° to 10° C., with isothermal conditions up to at least 26 kilometers. The lower zone he calls the "troposphere," and the upper zone the "stratosphere." The former is a region of violent atmospheric disturbances, for Hildebrandsson has shown that cyclones do not extend above the cirrus clouds, though anticyclones persist to greater heights, and therefore the "stratosphere" is lowest in the cyclone and highest in the anticyclone and its lower level sinks from the equator to the poles. The stratosphere, on the contrary, is a region of interlaced currents and small vertical movements.

The four following papers described the results of recent investigations and expeditions. General Rykatchef, director of the Central Physical Observatory at St. Petersburg, exhibited charts of aerial soundings at various Russian stations. The higher level of the great temperature inversion in anticyclones than in cyclones at St. Petersburg, and the isothermal condition prevailing in winter for several thousand meters above the ground at Asiatic stations were some of the phenomena illustrated. The most interesting report was presented by Professor Berson, assistant at Lindenberg Observatory, on his recent expedition to tropical East Africa and Lake Victoria Nyanza. On the coast, and from a specially chartered steamer on the lake, ballons-sondes, pilot balloons, and kites were sent up. The observations over the equator in the center of the continent showed very low temperatures at great heights (—84° C. at 17,000 meters), as did the expedition of Teisserenc de Bort and Rotch in the equatorial Atlantic, but with the difference that over the tropical continent there was a trace of the isothermal layer which was not found over the ocean. The vertical changes were as follows: Adiabatic decrease of temperature to 13,000 meters, between 13,000 and 14,000 meters a small inversion, and above 17,000 meters isothermal conditions. Above the southeast monsoon the wind was south-southwest and three times a westerly wind was observed between 15,000 and 18,000 meters above the great easterly equatorial current, which is supposed to prevail at all heights in these latitudes. Professor Palazzo, director of the Italian Meteorological Office, described his aerological expedition to

Zanzibar and to the east coast of Africa, in which ballons sondes and pilot balloons were launched from an Italian warship. Professor Hergesell gave some results of balloons sent up from a German cruiser in the neighborhood of the Canary Islands, and on the Peak of Teneriffe. He showed the effect of the distribution of barometric pressure on the trade wind, which is especially influenced by the displacement of the center of maximum pressure over the North Atlantic. Professor Hergesell reaffirmed his belief that the effect of the peak on the wind extends up to a height of 6 kilometers. Professor Rotch presented a volume giving an account and discussion of the first observations with ballons-sondes in America, which were made by him at St. Louis from 1904 to 1907.

The communications relating to new projects included the promises of Doctor van Bemmelen, of Batavia, to establish a kite station there, and of Mr. Davis, director of the Argentine Meteorological Office, to do the same in his country. M. de Massany, of Budapest, gave an account of an aerological observatory and aerodynamical laboratory about to be established at Kecskemet on the plains of Hungary, and Lieutenant Ferrari announced that a kite station was proposed near Rome.

Professor Hergesell spoke of the new observatory on the flank of the Peak of Teneriffe, which he had just inaugurated in portable buildings furnished by the German Emperor. Aerological stations in Spitzbergen and Teneriffe are of particular value and the desirability of the latter was expressed at the Milan conference. Col. Vives y Vich, the Spanish military representative, took exception to some of Professor Hergesell's statements, and the following facts were agreed upon: The aeronautical commission was ready to establish an observatory on the peak with the aid of the Prussian Government. The Spanish Government objected, but recognizing the scientific value of the enterprise it provisionally accepts the use of the temporary buildings offered by the Prussian Government, through Professor Hergesell, until permanent buildings can be erected. Until such time the buildings will be considered Spanish property and, while the observatory will be open to savants of all countries, no preference can be given to Germans. The conference expressed its thanks to both the German and Spanish governments and especially to the Spanish military aeronauts for establishing this observatory.

Professor Assmann read a suggestive paper on the application of aerological observations in aerial navigation. He cited the observations which were being made in the free air at various observatories

and by expeditions on the oceans. Eventually it will be possible to construct weather charts of the upper air which will enable predictions to be made of great value, especially for aerial navigation. Even now, before a dirigible balloon ascends from Berlin, the observations in the free air from four stations are consulted. These views were approved by several members and Doctor Bamler, of Essen, thought it possible to obtain continuous observations in a captive balloon maintained at a constant height.

In this connection the attention of the aero clubs was called to the importance of making meteorological observations in all manned balloon ascensions, and the assistance rendered in this respect by the Vienna Aero Club and the Austrian Minister of War were acknowledged.

It was voted to exchange copies of the traces of the aeronautic records between members on their request, and to send titles of new aerological publications to the Fortschritte der Physik in Germany and to the Monthly Weather Review in the United States.

The next meeting of the conference will be held at Vienna in the autumn of 1912.

Three sessions of the commission on a system of meteorological stations over the globe were held with Teisserenc de Bort as president and Professor Hildebrandsson as secretary. The former made a report on his project for international observing stations and the latter explained his proposition to the international committee in 1899 to establish meteorological stations around the great centers of action, and showed the compensating types of weather occurring simultaneously in different regions. Thirty-eight stations at important points around the globe, between latitude 70° N. and 50° S. were selected, at which, besides the routine observations, the insolation at a fixed altitude of the sun, the direction of the upper clouds, and the temperature of the sea are to be observed at the usual hour of the morning observation, except the insolation, which is that of the preceding day. For the study of the centers of action the monthly means of observations are to be sent by the cooperating institutes, to the president of the commission, but for the other system of stations the observations are to be telegraphed every day, or, if this is impossible, the weekly means can be telegraphed and like the daily observations published in the weather bulletins of the respective countries, where they will be available for study.

Although the week was chiefly occupied with the scientific sessions the Prince entertained members of the commissions three times at the

palace and once on his yacht, the *Princesse Alice,* where he demonstrated his methods of oceanographic investigation. These, as well as the aerological work of the Prince, were illustrated by an evening lecture given by his aide-de-camp, M. Bourée. The little remaining leisure was agreeably filled by a visit in automobiles to the Nice Observatory and by a performance at the opera.

UPPER AIR DATA.

By the Aerial Section—W. R. BLAIR in Charge.

I.—SUMMARY OF DATA FOR THE YEAR, JULY 1, 1907, TO JUNE 30, 1908.

The upper air data obtained during this first year consisted of daily, except Sunday, observations of wind direction, temperature, and pressure. The pressure has been used in the computation of the altitudes at which any changes or peculiarities in either of the other two elements occurred.

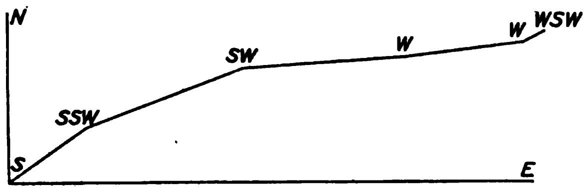

FIG. 7.

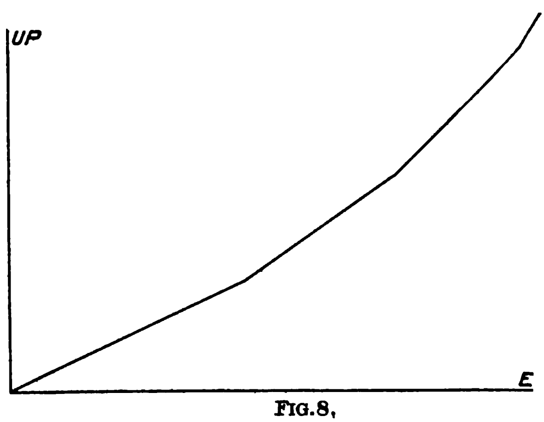

FIG. 8.

Figs. 7 and 8, made from observations taken on July 17, 1908, illustrate the method of observing wind directions aloft. Fig. 7 shows the horizontal projection of the kite wire in a flight in which the surface wind was south and the wind aloft nearly west. Fig. 8 shows the vertical projection of the same flight. Six kites were used. Their positions and the direction of the wind in which each flew at the time this particular observation was made are indicated in the chart. Such charts as these are not always necessary for the observation of wind directions to 16 points, but it is important that an observer who is to

estimate these directions without the use of a theodolite should in every case mentally make the projections. The tendency apparent to record more than the actual change in direction with altitude can easily be corrected in this way. The data necessary for the construction of the projections are the azimuth and elevation of each kite and the distances between the kites. These data should all be taken as nearly as possible at the same time.

The temperatures and pressures are recorded by a Richard meteorograph, in which the thermometer is a tube filled with toluene and the barometer is a Bourdon tube. Both of these elements are frequently compared with standard instruments.

For the purpose of summarizing the year's work the ascensions with the computed data belonging to them were arranged in three groups. The first group contained all observations made well within anticyclones, the second those made well within cyclones, and the third those which could not be placed in either of the two preceding groups. The air pressure at the surface reduced to sea level was usually above 764.5 millimeters in the first group, below 759.5 millimeters in the second group, and between these two pressures in the third. This method of grouping is itself the result of considerable study and seems to fairly well serve its purpose. This brings together into a given group only such free air observations as are characteristic, and may safely be thought of as accompanying given surface conditions.

Anticyclones have been grouped into those moving N., NE., ENE.. E., ESE., SE., and S., and the observations subgrouped accordingly, A series of four to six charts has been made for each group. These charts show the wind direction and velocity at the surface (526 meters above sea level) and the wind direction at each 1,000 meters above sea level as far up as the observations extend. Cyclones have been grouped into those moving NE., ENE., and E., and the observations charted as in the anticyclones.

In each chart, an arrow across the face shows the direction of motion of the disturbance, the center of the chart is the center of the disturbance (determined from the weather map of the day), the point of the small arrow shows the position of Mount Weather with reference to this storm center at the time of taking the observation. These small arrows point the direction toward which the wind is blowing and the number of lines in the feather indicates the wind velocity in meters per second at the 526 meter level. The radius of the outside circle in any chart represents a distance on the earth's surface of 2,000 kilometers.

While each of these series of charts is peculiarly interesting, there is in general a sufficient similarity in the relation of the wind directions in each series to the direction of the storm's motion to warrant the making of two series of mean charts, one for the anticyclones and one for the cyclones. For the purpose of taking mean wind directions, the ascensions are grouped by octants, those of each octant being subgrouped into observations made within 500 kilometers of the storm center, those made between 500 and 1,000 kilometers of the center and those made outside of 1,000 kilometers distance from the center. The octants are numbered counterclockwise beginning with the one in the storm front and immediately to the left of the large arrow showing the direction of the storm's motion. Means are taken of the observations made in octants having the same number; for anticyclones, figs. 13 to 17; for cyclones, figs. 22 to 25.

The mean of a given number of directions forming angles α, β, γ, with a fiducial direction is found by the formula,

$$\tan \varphi = \frac{\sin \alpha + \sin \beta + \sin \gamma + \dots}{\cos \alpha + \cos \beta + \cos \gamma + \dots}$$

where φ is the angle between the fiducial direction and the mean direction.

In the ten original series and the two mean series, there are in all 51 wind charts. One series of charts each has been selected from the observations made in anticyclones, and these together with the series of mean charts for each of these groups of observations appear in figs. 9 to 25, inclusive.

Those observations not included in the charts have been grouped into (1) observations made when the low pressure area was northwest, west, or southwest of the observatory and the high pressure area, northeast, east, or southeast, and (2) observations made when the low pressure area was northeast or east of the observatory and the high pressure-area was northwest, west, or southwest. These groups have been tabulated and appear in Tables 1 and 2, respectively.

Mean temperature gradients have been charted by seasons for each of the above subgroups of observations; but it has been found that, for the purpose of this summary, not only did the octants not need to be subdivided, but that octants 1 and 2, 3 and 4, etc., could be combined into quadrants I, II, III, and IV. The mean gradients are shown in figs. 26 to 35, inclusive. A number to the right and at the foot of each curve indicates the number of observations represented in the mean and, consequently, the weight to be given it.

TABLE 1.—*Low nw., w., or sw.; high ne., e., or se.*

Date.	Wind direction at—					Turning cw. or ccw.	Clouds.			Influence of prevailing westerlies apparent at—	Remarks.
	Surface 526	1,000	2,000	3,000	4,000		Am't.	Kind.	Dir.		
1907.	*M.*	*M.*	*M.*	*M.*	*M.*					*M.*	
July 1	s.	ssw.	......	......	......	cw.	Few	Ci.	nw.	......	
							Few	Cu.	s.	......	
July 3	nw.	n.	nnw.	......	......	cw.	4	S.-cu.	nnw.	......	
July 5	w.	w.	......	......	......	......	10	S.-cu.	w.	......	
July 6	s.	sse.	......	......	......	ccw.	1	S.-cu.	s.	......	
July 10	w.	w.	......	......	......	......	4	A.-cu.	wnw.	......	Thunderstorm and rain.
							2	Cu.-n.	w.	......	
July 11	s.	s.	sw.	sw.	w.	cw.	6	S.-cu.	sw.	1,500	
July 13	se.	se.	......	......	......	......	3	A.-cu.	w.	......	
							3	A.-s.	w.	......	
July 15	se.	se.	......	......	......	......	Dense	fog	......	......	
July 16	s.	s.	......	......	......	......	1	A.-cu.	w.	......	
							3	Cu.	s.	......	
July 19	nw.	ne.	......	......	......	cw.	8	S.	n.	......	
July 24	wnw.	wnw.	nw.	......	......	cw.	2	S.-cu.	wnw.	500	
July 31	nw.	nw.	......	......	......	......	0	......	......	......	
Aug. 6	nw.	nw.	wnw.	......	......	ccw.	1	S.-cu.	nnw.	500	No well developed high or low.
Aug. 7	nw.	nnw.	n.	......	......	cw.	6	S.-cu.	nw.	......	
Aug. 9	ese.	sse.	ssw.	......	......	cw.	Dense	fog	......	......	Thunderstorm and rain.
Aug. 10	ne.	e.	e.	......	......	cw.	Light	fog	......	......	Rain.
Aug. 12	s.	sw.	wsw.	......	......	cw.	1	Cu.	sw.	......	
Aug. 20	s.	sw.	......	......	......	cw.	5	S.-cu.	w.	......	
Aug. 27	s.	wsw.	w.	wnw.	......	cw.	10	S.	sw.	1,500	Light rain.
Sept. 10	se.	sw.	wsw.	......	......	cw.	Dense	fog	1,500	......	Light rain.
Sept. 11	s.	sw.	wsw.	......	......	cw.	Dense	fog	......	......	Light rain.
Sept. 20	s.	wsw.	......	......	......	cw.	0	......	......	......	
Sept. 28	se.	s.	......	......	......	cw.	10	A.-s.	sw.	......	
Oct. 7	s.	sw.	wsw.	wsw.	......	cw.	0	......	......	1,800	
Nov. 4	ssw.	ssw.	......	......	......	......	Few	Ci.	wsw.	......	
Nov. 5	s.	ssw.	......	......	......	cw.	4	A.-cu.	sw.	......	
							4	A.-s.	sw.	......	
Nov. 8	s.	sw.	w.	w.	w.	cw.	8	S.-cu.	w.	2,500	Light rain.
Nov. 9	s.	sw.	w.	w.	......	cw.	3	Ci.-s.	w.	2,300	
							3	S.-cu.	sw.	......	
Nov. 21	se.	ssw.	......	......	......	cw.	Dense	fog	......	......	
Nov. 28	sw.	w.	nw.	......	......	cw.	5	Ci.-s.	w.	......	
							5	A.-s.	w.	......	
Dec. 3	se.	s.	sw.	......	......	cw.	10	S.	w.	2,000	Light snow.
Dec. 9	se.	s.	......	......	......	cw.	Dense	fog	......	......	
Dec. 25	s.	sw.	w.	w.	......	cw.	2	Ci.	w.	2,400	
							2	A.-s.	w.	......	
Dec. 28	se.	w.	w.	......	......	cw.	5	Ci.	w.	1,900	
							5	S.-cu.	w.	......	
1908.											
Jan. 4	s.	sw.	sw.	sw.	......	cw.	10	S.	s.	2,300	Light snow.
							Dense	fog	......	......	
Jan. 16	sw.	wsw.	w.	w.	......	cw.	10	S.-cu.	w.	2,200	
Jan. 23	se.	s.	sw.	sw.	sw.	cw.	10	S.-cu.	w.	2,000	Light snow.
Jan. 25	sw.	w.	wnw.	......	......	cw.	2	Ci.-s.	w.	......	Standing clouds.
							2	A.-cu.	w.	......	
							2	S.-cu.	w.	......	
Jan. 28	sw.	sw.	wsw.	......	......	cw.	10	S.	w.	......	
Feb. 3	s.	w.	w.	......	......	cw.	Few	Ci.	w.	......	
Feb. 14	se.	sw.	sw.	sw.	sw.	cw.	Dense	fog	......	1,900	
Feb. 21	se.	w.	w.	wsw.	wsw.	cw.	5	Ci.-s.	w.	......	
Mar. 17	se.	sw.	w.	w.	......	cw.	10	S.	sw.	......	
							Dense	fog	......	2,300	
Mar. 25	se.	sw.	wsw.	w.	w.	cw.	5	A.-s.	w.	......	
							5	S.-cu.	w.	......	Light rain.
Mar. 27	se.	ssw.	sw.	w.	w.	cw.	Few	Ci.	w.	......	
Mar. 28	sw.	wsw.	w.	w.	......	cw.	8	S.	w.	2,400	Light rain.
Mar. 31	s.	sw.	w.	w.	w.	cw.	Dense	fog	......	2,200	
April 1	se.	ssw.	sw.	sw.	w.	cw.	Dense	fog	......	2,700	Light rain.
April 7	se.	s.	sw.	w.	......	cw.	8	Ci.	w.	2,200	
April 10	s.	sw.	w.	......	......	cw.	10	S.	w.	1,800	Light rain

TABLE 1.—*Low nw., w., or sw.; high ne., e., or se.*—Continued.

Date.	Wind direction at—					Turning cw. or ccw.	Clouds.			Influence of prevailing westerlies apparent at—	Remarks.
	Surface 526	1,000	2,000	3,000	4,000		Am't.	Kind.	Dir.		
	M.	*M.*	*M.*	*M.*	*M.*					*M.*	
April 18	s.	wsw.	wsw.	wsw.	......	cw.	10	S.	wsw.	1,400	Light rain.
May 4	n.	w.	......	......	......	ccw.	Dense	fog	......	......	Light rain.
May 5	se.	se.	......	......	......	......	10	S.	se.	......	Light rain.
May 6	se.	sse.	......	......	......	cw.	Dense	fog	......	......	Light rain.
May 11	sw.	w.	w.	wnw.	wnw.	cw.	3	Ci.	wnw.	1,200	Solar halo.
May 12	sw.	wsw.	wsw.	w.	......	cw.	1 1	A.-cu. S.-cu.	w. w.	 2,400	
May 14	w.	w.	w.	wsw.	......	ccw.	3 4	Ci.-cu. S.-cu.	wsw. w.	 1,600	
May 18	ne.	ene.	......	......	......	cw.	8	Ci.-s.	w.	......	Solar halo.
May 21	e.	ese.	ese.	......	......	cw.	Dense	fog	......	......	Light rain.
May 26	sw.	wsw.	......	......	......	cw.	7	Cu.	sw.	......	Thunderstorm and rain.
June 11	se.	ne.	nnw.	......	......	ccw.	5 5	A.-s. S.	w. e.	....	No well developed high or low.

TABLE 2.—*Low ne. or e.; high nw., w., or sw.*

Date.	Wind direction at—					Turning cw. or ccw.	Clouds.			Influence of prevailing westerlies apparent at—	Remarks.
	Surface 526	1,000	2,000	3,000	4,000		Am't.	Kind.	Dir.		
1907.	*M.*	*M.*	*M.*	*M.*	*M.*					*M.*	
July 8	nw.	w.	w.	w.	......	ccw.	3	Cu.	w.	500	
July 9	nw.	wnw.	wnw.	......	......	ccw.	6	S.-cu.	nw.	500	
July 17	w.	w.	w.	......	......	......	10	S.	sw.	500	Thunderstorm.
July 18	nw.	nw.	w.	......	......	ccw.	6	A.-cu.	w.	1,500	
July 22	nw.	nw.	nw.	nw.	nw.	......	0	......	......	1,200	
July 23	nw.	nw.	nw.	nw.	w.	ccw.	0	......	......	3,100	
July 25	nw.	nw.	nw.	......	......	......	0	......	......	1,700	
July 27	nw.	nnw.	nw.	wnw.	wnw.	ccw.	0	......	......	3,000	
Aug. 3	nw.	wnw.	ssw.	......	......	ccw.	5	Ci.-s.	w.	......	No well developed high or low.
Aug. 8	nw.	nw.	......	......	......	......	Few	S.-cu.	nw.	......	
Aug. 13	nw.	nw.	w.	......	......	ccw.	10	S.	nw.	1,300	
Aug. 21	w.	wnw.	......	......	......	cw.	0	......	......	......	
Aug. 24	nw.	nw.	nw.	......	......	......	6	S.-cu.	nw.	1,900	
Aug. 26	w.	nw.	nw.	......	......	cw.	0	......	......	......	No well developed high or low.
Aug. 28	nw.	wnw.	wnw.	......	......	ccw.	4 Light	S.-cu. fog	nw.	....	
Aug. 30	nw.	nw.	......	......	......	......	10	S.	s.	......	
Aug. 31	nw.	nnw.	nnw.	......	......	cw.	Few 3	Ci.-s. Cu.	nw. nw.	....	No well developed high or low.
Sept. 5	nw.	wnw.	w.	w.	w.	ccw.	3	A.-cu.	w.	1,500	
Sept. 6	nw.	nw.	nw.	wnw.	w.	ccw.	1	S.	nw.	2,100	
Sept. 7	nw.	nw.	......	......	......	......	3	Ci.-s.	w.	......	
Sept. 21	w.	nw.	......	......	......	cw.	0	......	......	......	
Sept. 25	nw.	nw.	nw.	......	......	......	1	S.-cu.	wnw.	......	
Oct. 12	nw.	nnw.	wnw.	......	......	ccw.	5	Cu.	wnw.	2,000	
Oct. 18	nw.	nw.	nw.	nw.	......	......	0	......	......	1,900	
Oct. 23	nw.	nw.	nw.	......	......	......	7	S.-cu.	w.	1,500	
Oct. 29	nw.	wnw.	wnw.	......	......	ccw.	1	Ci.	nw.	......	
Nov. 25	nw.	nw.	nw.	wnw.	w.	ccw.	2	Ci.-s.	nw.	2,600	
Dec. 2	nw.	wnw.	nw.	nw.	nw.	......	5	Ci.	w.	2,700	
Dec. 12	nw.	nw.	nw.	nw.	......	......	Few	S.-cu.	nnw.	2,300	
Dec. 16	wnw.	wnw.	......	......	......	......	Few	A.-cu.	w.	......	
Dec. 18	w.	w.	......	......	......	......	Dense	fog	......	......	

TABLE 2.—*Low ne. or e.; high nw., w., or sw.*—Continued.

Date.	Wind direction at— Surface 526.	1,000	2,000	3,000	4,000	Turning cw. or ccw.	Clouds. Am't.	Kind.	Dir.	Influence of prevailing westerlies apparent at—	Remarks.
1908.	*M.*	*M.*	*M.*	*M.*	*M.*				*M.*		
Jan. 9	nw.	nw.	nw.	......	......	......	Few	S.-cu.	wnw.	......	Standing clouds.
Jan. 14	nw.	nw.	nw.	......	......	......	Few	S.-cu.	wnw.	......	
Jan. 22	nw.	wnw.	wnw.	......	......	ccw.	Few	Ci.-s.	w.	......	
							3	S.cu.	w.	......	
Jan. 24	nw.	nnw.	n.	......	......	cw.	5	Ci.-s.	nw.	......	
							Few	S.-cu.	n.	......	
Jan. 29	nw.	nw.	nw.	w.	......	ccw.	5	Ci.-s.	nw.	......	
							5	A.-s.	nw.	2,100	
Feb. 17	nw.	nw.	wnw.	nw.	nw.	......	5	S.-cu.	wnw.	2,400	Light snow.
Feb. 20	nw.	nw.	......	......	......	......	Few	S.-cu.	nnw.	......	
Feb. 22	nw.	nw.	nw.	nw.	......	......	5	Ci.	w.	......	Light snow.
							5	S.-cu.	nw.	2,600	
Feb. 28	nw.	wnw.	......	......	......	ccw.	Few	S.	wnw.	......	
Mar. 7	nw.	wnw.	w.	......	......	ccw.	5	Ci.-s.	w.	......	
Mar. 12	nw.	nw.	nw.	nw.	nw.	......	Few	A.-cu.	nw.	1,800	
Mar. 14	nw.	nw.	nw.	......	......	......	3	Ci.-s.	nw.	......	
							3	Ci.-cu.	nw.	2,400	
Mar. 16	nw.	wnw.	wnw.	w.	......	ccw.	5	S.-cu.	wnw.	2,000	
Mar. 19	nw.	wnw.	wnw.	wnw.	......	ccw.	3	Ci.-cu.	w.	......	Standing cloud.
							3	A.-s.	w.	......	
							4	S.-cu.	nw.	2,300	
April 3	nw.	wnw.	w.	w.	w.	ccw.	7	S.-cu.	w.	2,800	
April 13	nw.	wnw.	wnw.	wnw.	......	ccw.	0	......	......	......	
April 21	nw.	nw.	nw.	nw.	......	......	Few	S.-cu.	w.	......	
May 13	nw.	wnw.	......	......	......	ccw.	5	Ci.-s.	wnw.	......	Standing cloud.
May 27	nw.	wnw.	w.	......	......	ccw.	6	Ci.s.-	w.	......	
							2	A.-s.	w.	......	
June 1	nw.	nw.	wnw.	wnw.	wnw.	ccw.	2	S.-cu.	nw.	2,300	
June 9	nw.	s.	s.	s.	......	ccw.	2	Ci.	w.	......	Thunderstorm during flight.
							8	S.	s.	......	
June 15	nw.	sw.	sw.	sw.	......	ccw.	5	A.-s.	sw.	......	Light rain.
							5	S.	w.	1,200	
June 16	nw.	nnw.	wnw.	......	......	ccw.	1	Ci.-s.	w.	......	
June 20	nw.	wnw.	w.	w.	w.	ccw.	7	Ci.-s.	w.	......	
							2	A.-s.	w.	900	Solar halo.
June 22	nw.	n.	n.	......	......	cw.	9	Ci.-s.	wsw.	......	Solar halo. No well developed high or low.
June 23	nw.	0	0	......	......	......	7	Ci.-s.	nw.	......	Solar halo.
June 24	nw.	wnw.	......	......	......	ccw.	Few	Ci.	w.	......	
June 25	nw.	nw.	wnw.	wnw.	w.	ccw.	3	Ci.-s.	w.	......	
							2	A.-s.	wnw.	2,700	
June 26	nw.	ne.	n.	......	......	cw.	2	A.-cu.	wnw.	......	
							2	Cu.	n.	......	
June 30	nw.	wnw.	w.	wsw.	wsw.	ccw.	8	A.-cu.	w.	1,600	

The work of reducing the data for these charts and tables, also the drawing of the charts themselves, has been done for the above groups by Messrs. Wood, Marks, and Gregg, respectively.

There are 138 observations in the first group, 57 in the second, and 122 in the third. This unequal distribution is due to the fact that most lows pass well to the north of Mount Weather, only a few (usually of small area) passing southeast or south, of the station while highs pass directly over it. It follows that, while the means obtained in the first and third groups are fairly representative, the means in the second group are not always so.

The observations made in the right, usually the south, half of a high pressure area do not extend to so great a height as those made in the left; similarly those in the left, usually the north, half of a low pressure area do not extend to so great a height as those in the right. In either case the easterly winds are shallow. The observations made by both kites and captive balloons show that above the shallow surface currents there is a calm, while those balloons that have gone through the calm come into a westerly wind at an altitude of about 2,000 meters.

In both anticyclones and cyclones the station surface winds show a tendency to cross the mountain range[1] at right angles, while at an altitude of 1,000 meters above sea level there is very good conformity of the wind directions to the pressure gradient. Even at this level, however, those wind directions observed in anticyclones have a noticeable component in the direction of motion of the disturbance. This component has increased at the 2,000 meter and higher levels. A similar component is not noticeable in the cyclone, at least until the 3,000 meter level is reached, but here the observations are few in number and confined to the right side of the storm, so that a general conclusion may hardly be based upon them. With the exception of the component noted the wind directions seem to conform to the pressure gradients belonging to their respective types of storm as far up as these observations extend.

In Tables 1 and 2 many of the observations listed were made when there were no pronounced storm conditions present. These seldom if ever extend over 2,000 meters above sea level. Whether the surface winds be from the southeast or northwest quarters the change in the direction with altitude is such as to introduce a strong westerly component. It is probable that, in this group of observations, the westerly component is comparatively more prominent because of the absence of well defined storm conditions.

The charts showing the mean temperature gradients are instructive in a general way only. Temperature inversions are observed in the lower levels of anticyclones in most of the ascensions. Figures 26 to 30 show this fact, especially in the winter and spring means, i. e., when the highs are well defined. Observations in quadrants I and II of cyclones are too few and too near the surface to get much from, but

[1] The Blue Ridge Mountain Range, on which the Mount Weather Observatory is located, trends northeast and southwest for about 10 degrees of a great circle from northern Georgia to northern Maryland, and in some portions attain altitudes averaging 1,500 meters.—EDITOR.

other observations, of which the means appear in figs. 31, 34, and 35, show few inversions. The uniformly large decrease in temperature with altitude at all levels is often interrupted by isothermal conditions which occur in fog and cloud layers, e. g., in fig. 35, the three observations averaged for the winter gradient were made in dense fogs. On the whole it is shown that the decrease in temperature with altitude is greater when the surface air pressure is increasing.

With the summary of this year's work will be combined, as soon as practicable, a similar summary for the year July 1, 1908, to June 30, 1909.

II.—UPPER AIR TEMPERATURES. DATA FOR JANUARY, FEBRUARY, AND MARCH, 1909.

The prevailing wind for this period was northwest, but more decidedly so in March than in January or February. The air movement at the surface increased from an average hourly velocity of 27.6 kilometers in January to 32.7 kilometers in March, the average for the three months being 31.9 kilometers per hour.

The mean of the highest altitudes reached daily in March is 3,041 meters and for the three months, 2,667 meters, the latter being 148 meters greater than the corresponding mean for the three months previous. The highest altitude reached was 5,153 meters, February 18. Figs. 36, 37, and 38 show the mean hourly temperatures at Mount Weather, Trapp, and Audley for the period. The mean daily range is decidedly less for these three months than for July, August, and September (see Vol. II, Part 1 of this Bulletin). The cloud observations for the period are of interest in this connection:

Month.	Number of days.			Mean cloudiness.
	Clear.	Partly cloudy.	Cloudy.	
1909.				
January	9	10	12	6.2
February	5	12	11	6.4
March	10	8	13	5.5

The temperature data for these three months seem to support well the statements made in the last number of the Bulletin (Upper air temperatures for October, November, and December, 1908), with reference to the relation between surface and upper air temperatures and surface pressure.

WITHIN AREAS OF HIGH PRESSURE.

Decided maxima of pressure occurred at the surface on January 8,

13, and 19; February 1, 8, 13, 18, 23, and 26; March 1, 5, 8, 12, and 23. A glance at the isothermal charts Nos. XIII to XVIII, inclusive, will show that these are all accompanied by the characteristic lowering of the temperature as the barometer rises, also by the peculiarities in the temperature gradient described in the article above referred to.

On January 19 to 23 there occured a persistent inversion of temperature somewhat similar to that of October 1 to 5 and under similar conditions. In this case the ground was snow-covered and the higher temperature was longer in reaching the earth's surface. During this period some very cold weather, followed by a short period of weather remarkably mild for the season, occurred at Mount Weather. The data obtained from the kite flights show that the cold wave was confined almost exclusively to the lower air layers. The minimum temperature for the year at Audley (elevation 152 meters above sea level) occurred on the morning of the 19th, while the temperature at 2,146 meters was 20.2° C. higher than at Audley. The altitude at which the maximum temperature of the inversion was found was lower each succeeding day, reaching the mountain top in five days and the valleys in one day more. A low that passed near Mount Weather on the morning of the 17th caused a snowfall of nearly 5 inches. An area of high pressure which was central north of Lake Huron on the 18th had moved toward the coast, and extended from North Carolina to New Brunswick on the 19th. Pressure remained high over Mount Weather until the 24th. An area of low pressure that moved east from the Lakes to the Atlantic Ocean influenced the weather conditions at Mount Weather from the 23d to the 26th. The sky was almost cloudless from the 18th to the 23d, when clouds appeared and a trace of rain fell. The 24th and 25th were partly cloudy and the 26th was clear. Table 1 shows for each day the temperature at the highest altitude reached by the kites, the altitude of the maximum temperature of the inversion, and the temperature at Mount Weather and at Audley, together with the weather conditions which prevailed during the period. The data for the table was collected and arranged by Mr. Sherry in connection with his work in reducing the mountain and valley data.

The descending air in the center of an anticyclone heats adiabatically, but near the ground the warming due to this cause is overcome by the excessive loss of heat by radiation and conduction to the snow-covered ground. The cooling at low altitudes due to radiation on clear, calm nights is shown by the low temperatures reached at Audley during the mornings of January 19 to 22. This

pronounced variation of the air temperature from the normal, negatively in the surface layer and positively in that just overlying it, is therefore due both to cooling of the former and warming up of the latter. The coldest day of the period was January 19. The barometric pressure reached its maximum value on that day and gradually decreased thereafter.

TABLE 1.

Date.	Hour.	Temperature at different altitudes.						Wind.		Character of day.
		Audley (152 m.).	Mount Weather (526 m.).	Aloft.				Direction.	Velocity.	
				Altitude.	Temp.	Altitude.	Temp.			
	a. m.	C.	C.	Meters.	C.	Meters.	C.			
Jan. 18	10	− 1.7	− 4.4	963	− 8.7	1,240	− 4.4	nw-ne.	Mod'te..	Clear.
19	9	−15.0	−11.4	2,146	5.2	4,279	− 9.5	se-sw.	Light....	Clear.
20	9	− 9.4	0.7	1,195	7.3	1,391	3.8	var.	Light....	Clear.
21	8	− 6.1	4.0	1,028	9.6	1,392	7.1	var.	Light....	Clear.
22	10	0.0	11.0	890	18.5	1,122	11.6	var.	Light....	Clear.
23	11	6.1	12.2	952	13.8	3,599	− 8.7	sw.	Light....	Cloudy.
24	10	6.1	16.7	....	....	....	....	wnw.	Light....	Pt. cldy.
25	10	10.6	10.9	1,747	2.7	1,879 2,077	6.1 3.7	nw.	Light....	Pt. cldy.
26	9	4.0	0.6	1,050	− 5.6	2,650	−16.3	nw.	Mod'te..	Clear.

The general movement of the surface air for the day preceeding the cold weather was from the north. The whole region over which this air moved was covered with snow, and owing to the reflection of the sun's heat by the snow and to its consumption in melting, but little warming of the lower air and the ground occurred during the day, while, the weather being clear, the loss of heat by radiation during the night was considerable. The cold air from the Lake region thus reached Virginia[2] with but little change in temperature.

The cold surface air whose direction of movement after the 19th was variable, was overrun by a warmer mass of air which was found at a lower altitude from day to day until the 26th, when it had reached the valley stations, and the temperature then decreased uniformly with altitude. The slow descent of the warmer air was well illustrated by the melting of the snow which covered the ground at the time. In general the snow in the valleys is melted before that on the mountain but the contrary occurred in this instance. On January 23 the snow had entirely disappeared from the mountain top, while it was still about 2 inches deep in the valleys. The day following the snow melted farther down the mountain side, but still entirely covered the ground in the valleys. The snow did not leave the valleys until January 26, three days after it had entirely disappeared from the mountain top.

[2] Mount Weather is about 400 miles southeast of Lake Erie.—EDITOR.

WITHIN AREAS OF LOW PRESSURE.

Decided minima of surface pressure occurred on January 6, a. m.; 12, a. m.; 17, p. m.; 28, a. m., and 29, a. m.; February 6, a. m.; 10, a. m.; 16, p. m.; 19, p. m., and 24, p. m.; March 4, a. m.; 10, a. m.; 14, a. m., and 25, a. m. In every case as the barometer fell toward these minima there was a decided increase in temperature at all levels reached by the kites. On January 12 and 17, February 16 and 19, and on March 4 the area of low pressure passed near Mount Weather. The low of January 17 was but a slight depression in a large high pressure area.

In thirty-one of the flights made during this period a gradient of 0.8 degrees or more per 100 meters was observed for part or all of the altitude. In nineteen of these cases the surface air pressure was below normal; sixteen of the nineteen occurred just after the minimum pressure had passed, while only three occurred before or at the time of passing of the minimum pressure. Four of the thirty-one cases were observed when the pressure was just above normal, but still rising. Four were observed at the time the high was central over the station and always at noon or later in the day. In the twenty-eight cases mentioned the large gradient began at the surface and extended, in the first twenty-four, to a mean height of 1,600 meters above sea level; in the last four, to 870 meters. In the four remaining of the thirty-one cases the gradient of 0.8 or more degrees began at 1,000, 1,200, 1,800, and 1,880 meters above sea level and was observed to an altitude of 2,425, 3,685, 2,800, and 4,425 meters respectively. These last all occurred while the air pressure at the lower station was above normal, but always on the border of the low pressure area; three while this pressure was on the decrease; one while it was on the increase.

In twenty of the thirty-one observations under consideration the gradient showed the adiabatic rate of cooling, and, with the exception of three which were coincident with maxima of surface pressure and can be attributed to the heating of the air near the earth's surface at such times, were observed at pressures below the normal but after the minimum of pressure had passed the station.

III.—CONCLUSIONS.[3]

The facts set forth in Parts I and II of this article seem to show

[3] It seems hardly necessary, though advisable, to interpolate here that these conclusions, as all others to which the Aerial Section gives expression from time to time, are based upon the data available and are subject to modification or rejection in the light of additional data.—*The Author.*

that low and high pressure areas are being continually recreated in the direction of their motion by the liberation of latent heat of condensation and the cooling due to evaporation, respectively. The heating and cooling due to these causes is continually in progress within the moist stratum (the lower. 3,000 or 4,000 meters) of the atmosphere, and well in the front of the respective areas. The former seems to take place at from 500 to 2,000 meters above sea level, the latter at from 2,000 to 3,500 meters.

Anticyclones, being recreated at higher levels, are moving forward with the westerly current prevailing at those levels at the same time that the descending current in the anticyclone's center moves toward the earth's surface. The axis of the anticyclone is therefore inclined forward.[4] On the other hand cyclones, being recreated at lower levels, do not, in most cases, move forward with a velocity as great as that of the ascending current in the cyclone's center. The result is that the axis of the cyclone is inclined backward[5] up to an altitude (about 2,000 meters above sea level) depending on the velocity of the ascending current and the level at which condensation is taking place. In Vol. II, Part 2, p. 72–4, of the Bulletin this altitude has been called the cyclone or storm depth. It seems to be, as there shown, related to the cyclone intensity and rate of movement. At higher levels, i. e., where the ascending current encounters the westerly current of greater velocity, the axis of the cyclone inclines forward. It will be observed that the amount of inclination backward is different for different cyclones, and further, that this factor together with the three discussed in the article above referred to operate to preserve the equilibrium of the cyclone.

In anticyclones there seems to be a decided widening in area of the anticyclone's influence at the earth's surface and immediately above it. This is probably due to the spreading out of the descending air current in the center. The influence of the cyclone seems to cover a greater area at about the 2,000-meter level than nearer the earth's surface. In both cyclones and anticyclones it is probable that the upper strata follow a more regular course than the lower, and influence to some extent the direction of motion as well as the velocity of the lower strata.

In addition to the data set forth in the work of Loomis and referred to above, these conclusions are supported by the following facts:

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[4] Bulletin of the Mount Weather Observatory, Vol. II, Part 1, p. 80.

[5] Loomis's Contributions to Meteorology, paper No. 10, and Davis's Meteorology, p. 225.

I.—IN CYCLONES.

1. The cyclone paths are found to pass through the regions of greater surface humidity.

2. The wind circulation conforms to the pressure gradient up to about the 2,000-meter level, as though the cyclone were standing still. (Figs. 22 to 25.)

3. The decrease in temperature with altitude is decidedly greater when the surface air pressure is on the increase than when it is on the decrease. This is due to the cooling aloft in the first case and to the heating aloft in the second.

4. At levels of 3,000 meters and over above sea, the winds in all parts of the cyclone are westerly, but of much greater velocity on the right than on the left side as one faces the direction of the storm's progress.

II.—IN ANTICYCLONES.

1. The anticyclone seems to follow rather closely the southwest quadrant of the preceding cyclone. It experiences no difficulty in traversing arid or dry regions.

2. The wind circulation, while conforming to the pressure gradient, shows a decided component in the direction of the anticyclone's progress, beginning at the 1,000-meter level (figs. 13 to 17), 3 and 4. As in 3 and 4 under I.

By some it is thought that the westerly currents in all parts of the high or low pressure area at the 3,000-meter level argues that the isobars are not closed[6] on the north side of a cyclone or the south side of an anticyclone. This is not a necessary conclusion for, if the component in wind direction and velocity, due to the forward motion of the area as a whole, could be eliminated from the circulation within the area, i. e., if the area could stand still relatively to the earth's surface, the circulation at these higher levels would be approximately symmetrical as to direction and velocity.

Observations upon clouds[7] and with sounding balloons have shown that the influence of the cyclone or anticyclone upon the wind circulation extends at least to the level of the cirrus clouds, in all probability to the permanent inversion.

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[6] Nature, May 20, 1909. p, 354.

[7] Monthly Weather Review, January to July, 1902.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.					Meters p. s.						Meters p. s.
Jan. 1.	Mm.	° C.	%			Meters.	Mm.	° C.	%		
7:25 a. m.	720.8	− 7.2	89	nw.	8.5	526	720.8	− 7.2	89	nw.	8.5
7:36 a. m.	720.9	− 7.2	85	nw.	8.5	906	686.4	−10.0	......	nw.	....
7:45 a. m.	721.0	− 7.2	85	nw.	8.9	1,370	646.6	− 7.6	......	nw.	....
8:15 a. m.	721.2	− 6.9	84	nw.	9.8	1,930	601.8	− 7.9	......	nw.	....
8:26 a. m.	721.3	− 6.9	85	nw.	10.7	2,008	595.9	− 8.8	......	nw.	....
8:38 a. m.	721.4	− 6.9	85	nw.	9.8	2,184	582.7	− 7.5	......	nw.	....
9:10 a. m.	721.6	− 6.7	85	nw.	9.8	2,754	541.3	−11.5	......	wnw.	....
9:30 a. m.	721.8	− 6.2	78	nw.	8.9	3,218	509.8	−14.6	......	wnw.	....
9:40 a. m.	721.9	− 5.8	79	nw.	7.2	526	721.9	− 5.8	79	nw.	7.2
Jan. 2.											
8:52 a. m.	725.1	− 3.5	54	se.	5.4	526	725.1	− 3.5	54	se.	5.4
9:00 a. m.	725.2	− 3.3	56	se.	5.4	822	698.5	− 4.5	......	ssw.	....
9:35 a. m.	725.2	− 2.8	65	se.	4.9	1,175	668.0	− 4.5	......	sw.	....
9:42 a. m.	725.2	− 2.9	67	se.	5.4	1,609	631.9	− 7.4	......	w.	....
10:53 a. m.	725.2	− 1.4	68	se.	6.3	3,234	513.5	−10.0	......	w.	....
11:10 a. m.	725.1	− 1.1	60	se.	5.8	2,990	530.1	− 9.0	......	w.	....
12:22 p. m.	724.8	0.0	60	se.	5.8	526	724.8	0.0	60	se.	5.8
Jan. 4.											
7:42 a. m.	718.6	6.1	62	wnw.	4.9	526	718.6	6.1	62	wnw.	4.9
8:10 a. m.	718.8	6.1	68	w.	4.5	942	683.4	8.2	......	w.	....
9:26 a. m.	718.9	7.1	59	wnw.	4.5	1,381	652.0	7.0	......	wnw.	....
10:12 a. m.	719.0	8.0	57	wnw.	4.0	1,042	676.0	8.9	......	wnw.	....
10:37 a. m.	718.9	8.9	54	wnw.	3.1	526	718.9	8.9	54	wnw.	3.1
Jan. 5.											
9:47 a. m.	712.7	8.6	100	s.	4.5	526	712.7	8.6	100	s.	4.5
9:50 a. m.	712.7	8.7	100	s.	4.5	858	684.8	9.8	......	ssw.	....
10:05 a. m.	712.7	8.9	100	s.	4.5	1,283	650.5	7.1	......	ssw.	....
10:18 a. m.	712.6	9.1	100	s.	4.5	1,901	603.1	3.2	......	ssw.	....
11:00 a. m.	712.2	8.9	100	se.	4.5	2,254	576.5	0.8	......	ssw.	....
12:00 m.	711.8	9.3	100	se.	4.5	526	711.8	9.3	100	se.	4.5

January 1, 1909.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 5,800 m., at the maximum altitude.

From 5/10 to 8/10 A.-Cu. moving from the west during the flight.

An extensive area of high pressure was central over Iowa and pressure was low over Newfoundland.

January 2, 1909.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 6,000 m.; at maximum altitude, 5,000 m.

From 3/10 to a few St.-Cu. moving from the west until 9:40 a. m. and from 2/10 to 6/10 A.-Cu. from the west thereafter.

A high was central over Virginia and a low over Alberta.

January 4, 1909.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 2,300 m.; at the maximum altitude, 1,800 m.

At the beginning 4/10 Ci.-Cu. and 5/10 St.-Cu. moving from west. The lower clouds had disappeared at the end of the flight. A solar halo from 9:08 to 9:18 a. m.

Low pressure was central over southern Minnesota and pressure was high over the middle Atlantic coast.

January 5, 1909.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,300 m., at maximum altitude.

Light rain, accompanied by dense fog, continued during the flight.

Highs were central over New Brunswick and Montana. A trough of low pressure extended from Ontario to the Gulf.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Jan. 6.	Mm.	° C.	%		Meters p. s.	Meters.	Mm.	° C.	%		Meters p. s.
8:56 a. m.	708.9	7.4	79	nw.	12.5	526	708.9	7.4	79	nw.	12.5
9:04 a. m.	709.0	7.7	76	nw.	16.1	879	679.2	5.2	......	wnw.	....
9:14 a. m.	709.1	7.7	75	nw.	18.4	1,148	657.7	4.6	......	wnw.	....
9:53 a. m.	709.7	7.4	79	nw.	10.7	1,327	643.7	9.2	......	wnw.	....
10:28 a. m.	710.0	7.6	75	nw.	15.2	2,123	584.8	5.3	......	wnw.	....
11:09 a. m.	710.1	7.6	72	nw.	19.7	2,842	534.8	0.9	......	w.	....
11:34 a. m.	710.0	6.9	71	nw.	18.8	1,987	597.6	6.0	......	wnw.	....
11:56 a. m.	709.9	7.2	61	nw.	20.6	1,252	650.0	7.1	......	wnw.	....
12:08 p. m.	710.0	7.1	63	nw.	17.0	1,056	665.8	2.0	......	wnw.	....
12:14 p. m.	710.1	6.1	67	nw.	20.6	874	680.5	8.7	......	wnw.	....
12:26 p. m.	710.3	6.7	64	nw.	21.5	526	710.3	6.7	64	nw.	21.5
Jan. 7.											
7:42 a. m.	728.5	−11.4	96	nnw.	6.7	526	728.5	−11.4	96	nnw.	6.7
7:59 a. m.	723.8	−11.7	96	nnw.	6.7	882	695.3	−14.5	......	n.	....
9:28 a. m.	725.6	−11.4	100	n.	4.9	1,800	655.1	−16.2	......	nne.	....
10:40 a. m.	725.7	−11.1	96	n.	3.1	1,706	621.9	−11.4	......	n.	....
10:56 a. m.	725.7	−10.9	98	n.	3.6	1,312	653.1	−15.9	......	ne.	....
11:10 a. m.	725.6	−11.0	98	n.	4.0	983	683.2	−16.7	......	ne.	....
11:15 a. m.	725.6	−11.0	98	n.	3.1	526	725.6	−11.0	98	n.	3.1
Jan. 8.											
7:57 a. m.	725.4	− 9.4	100	se.	4.0	526	725.4	− 9.4	100	se.	4.0
8:08 a. m.	725.4	− 9.4	100	se.	3.6	850	696.8	− 5.8	......	ssw.	....
8:29 a. m.	725.6	− 9.3	100	se.	4.0	1,242	661.7	− 7.9	......	ssw.	....
8:45 a. m.	725.7	− 9.2	100	se.	3.6	853	695.8	− 6.6	......	s.	....
8:58 p. m.	725.8	− 8.3	100	se.	3.6	526	725.8	− 8.3	100	se.	3.6

January 6, 1909.—Three kites were used; lifting surface, 12.4 sq. m. Wire out, 5,350 m.; at the maximum altitude, 4,500 m.

About 1/10 Ci.-Cu. and 2/10 St.-Cu. moving from the west at the beginning increased to 4/10 of each by 9:50 a. m. and then decreased to 2/10 Ci.-Cu. and 1/10 St.-Cu. by the end of the flight.

An extensive high was central over South Dakota and pressure was low over the lower St. Lawrence.

January 7, 1909.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 3,500 m., at maximum altitude.

The sky was overcast with very low clouds moving from the north. Light snow fell at intervals.

Very high pressure, central over Wisconsin, covered the entire country.

January 8, 1909.—Two kites were used; lifting surface, 13.1 sq. m. Wire out, 1,000 m., at the maximum altitude.

The sky was covered with St. moving from the south-southwest during the flight.

A high was central over the Gulf of St. Lawrence and a low over southern Idaho

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.	Mm.	° C.	%		Meters p. s.	Meters.	Mm.	° C.	%		Meters p. s.
Jan. 9.											
7:31 a. m.	723.6	— 7.2	97	se.	4.5	526	723.6	— 7.2	97	se.	4.5
7:39 a. m.	723.5	— 7.5	97	se.	4.0	906	689.1	— 5.7	......	s.	....
7:57 a. m.	723.5	— 7.6	100	se.	8.6	1,141	669.0	— 8.0	......	ssw.	....
8:14 a. m.	723.5	— 7.3	100	se.	4.0	1,856	651.3	5.7	......	ssw.	....
8:33 a. m.	723.6	— 7.8	100	se.	4.0	1,710	628.8	8.7	......	ssw.	....
8:49 a. m.	723.7	— 6.9	100	se.	3.6	1,815	615.9	9.6	......	ssw.	....
9:29 a. m.	723.8	— 6.7	100	se.	4.0	2,018	600.5	7.4	......	ssw.	....
9:40 a. m.	723.9	— 6.2	100	se.	8.6	2,802	546.0	0.9	......	sw.	....
9:55 a. m.	724.0	— 5.7	100	se.	3.1	1,917	606.4	7.7	......	sw.	....
10:07 a. m.	724.2	— 5.5	97	se.	3.1	1,867	651.3	8.4	......	sw.	....
10:16 a. m.	724.0	— 5.3	96	se.	2.7	1,173	667.0	— 2.4	......	sw.	....
10:27 a. m.	723.9	— 5.3	96	se.	8.1	914	689.1	— 4.8	......	ssw.	....
10:31 a. m.	723.9	— 5.5	96	se.	8.1	526	723.9	— 5.5	96	se.	8.1
Jan. 11.											
7:33 a. m.	716.5	9.4	79	w.	5.4	526	716.5	9.4	79	w.	5.4
7:38 a. m.	716.5	9.7	78	w.	5.4	789	694.3	11.9	......	wsw.	....
8:18 a. m.	716.7	9.4	80	w.	4.9	1,439	642.1	5.8	......	w.	....
8:38 a. m.	716.8	10.2	80	wsw.	6.7	1,769	616.9	8.1	......	wnw.	....
8:40 a. m.	716.8	10.9	79	wsw.	6.7	1,899	606.9	4.6	......	wnw.	....
8:50 a. m.	716.8	11.0	75	wsw.	6.7	2,543	560.6	1.1	......	wnw.	....
8:54 a. m.	716.9	11.4	75	wsw.	6.7	2,809	542.9	6.4	......	wnw.	....
9:15 a. m.	717.0	11.1	75	w.	4.0	8,425	503.5	2.0	......	w.	....
9:25 a. m.	717.1	11.6	74	w.	4.0	526	717.1	11.6	74	w.	4.0
Jan. 12.											
1:44 p. m.	714.9	— 1.6	87	nw.	19.7	526	714.9	— 1.6	87	nw.	19.7
1:46 p. m.	715.0	— 1.6	87	nw.	19.7	800	690.8	— 3.6	......	nw.	....
1:55 p. m.	715.0	— 1.6	83	nw.	19.7	881	688.2	0.3	......	wnw.	....
2:08 p. m.	715.2	— 1.7	80	nw.	20.6	1,106	665.4	5.7	......	w.	....
2:09 p. m.	715.2	— 1.7	79	nw.	18.8	1,471	636.2	3.0	......	wsw.	....
2:17 p. m.	715.3	— 1.9	82	nw.	20.6	1,552	629.8	5.3	......	wsw.	....
2:30 p. m.	715.2	— 2.1	83	nw.	21.5	526	715.2	— 2.1	83	nw.	21.5

January 9, 1909.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 4,000 m.; at maximum altitude, 3,000 m.

St. moving from the south-southwest covered the sky during the flight. Very light snow fell from 9:20 a. m. until the end of the flight. The head kite entered the clouds at 7:45 and emerged therefrom at 10:22 a. m.

High pressure, central over New England, covered the eastern United States.

January 11, 1909.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 4,267 m., at maximum altitude.

About 9/10 St.-Cu. moving from the west during the flight. The base of the clouds was about 1,400 m. above sea level.

An extensive area of high pressure was central over southeastern Montana and a second high was over the South Carolina coast. Pressure was low over New Brunswick.

January 12, 1909.—Two kites were used; lifting surface, 10.8 sq. m. Wire out, 2,662 m., at maximum altitude.

The sky was overcast with St. moving from the west-southwest.

An elongated low was central over western Virginia, and high pressure north of Lake Ontario and over Illinois.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.											
Jan. 13.	Mm.	° C.	%		Meters p. s.	Meters.	Mm.	° C.	%		Meters p. s.
8:32 a. m.	728.3	— 8.6	88	ene.	4.5	526	728.3	— 8.6	88	ene.	4.5
10:02 a. m.	728.5	— 8.0	72	ene.	4.9	976	687.3	—11.3	......	e.	....
10:31 a. m.	728.4	— 7.7	72	ene.	4.5	1,252	663.2	— 9.9	......	e.	....
11:35 a. m.	727.9	— 6.7	74	e.	4.5	1,379	648.2	— 6.0	......	ese.	....
1:38 p. m.	726.5	— 6.9	69	e.	5.8	1,500	641.8	— 8.0	......	se.	....
1:50 p. m.	726.4	— 6.9	69	ese.	5.4	1,566	635.5	— 5.0	......	s.	....
1:55 p. m.	726.3	— 6.9	78	ese.	5.8	1,926	607.1	— 1.5	......	sw.	....
2:02 p. m.	726.8	— 7.2	85	ese.	6.3	526	726.8	— 7.2	85	ese.	6.3
Jan. 14.											
8:27 p. m.	719.4	— 1.4	100	s.	2.7	526	719.4	— 1.4	100	s.	2.7
8:46 p. m.	719.3	— 1.8	100	se.	3.6	899	687.3	9.9	......	ssw.	....
8:56 p. m.	719.2	0.0	92	se.	2.2	1,215	661.5	9.1	......	wsw.	....
9:15 p. m.	719.2	1.7	82	w.	3.6	878	689.1	11.3	......	sw.	....
9:16 p. m.	719.2	1.7	91	w.	3.6	526	719.2	1.7	91	w.	3.6
Jan. 15.											
7:37 a. m.	719.2	7.2	100	w.	2.7	526	719.2	7.2	100	w.	2.7
7:55 a. m.	719.3	7.4	100	w.	4.0	690	705.3	9.8	......	wnw.	....
8:38 a. m.	719.6	6.7	100	wnw.	3.6	1,252	659 1	6.6	......	w.	....
8:58 a. m.	719.9	6.8	100	wnw.	4.0	1,656	627.7	4.2	......	wnw.	....
9:10 a. m.	719.9	6.8	100	wnw.	3.6	1,906	608.6	2.8	......	w.	....
9:15 a. m.	719.9	6.7	100	wnw.	3.6	2,109	593.7	5.7	......	w.	....
9:56 a. m.	720.2	6.6	100	wnw.	4.5	2,972	534.0	0.1	......	w.	....
10:16 a. m.	720.4	6.4	100	nw.	2.7	3,081	530.3	0.8	......	w.	....
11:03 a. m.	720.6	4.2	96	nnw.	7.6	2,164	590.0	5.2	......	wnw.	....
11:09 a. m.	720.8	4.0	97	nnw.	8.5	2,039	599.8	2.5	......	w.	....
11:18 a. m.	720.8	3.8	96	nnw.	8.0	1,662	627.7	5.2	......	w.	....
11:28 a. m.	720.8	3.3	98	nnw.	7.6	1,145	668.4	8.3	......	w.	....
11:36 a. m.	720.7	3.2	97	nw.	7.6	767	699.7	6.0	......	nw.	....
11:43 a. m.	720.6	2.9	97	nw.	8.0	526	720.6	2.9	97	nw.	8.0

January 13, 1909.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 3,000 m., at maximum altitude.

From 2/10 to 8/10 A.-Cu. moving from the west until 11:30 a. m., and from 2/10 to 10/10 A.-St. from the west until 12:30 p. m. After 12:45 p. m. 10/10 Nb. moving from the southwest. Light snow began at 12:45 p. m. and was gradually replaced by sleet, which continued after the close of the flight.

A high was central over the lower St. Lawrence Valley and a low over northern Nevada.

January 14, 1909.—One kite was used; lifting surface, 6.3 sq. m. Wire out, 1,000 m., at maximum altitude.

Dense fog prevailed until 8:50 p. m., after which the sky was overcast with St. moving from a westerly direction. Light rain began at 9:16 p. m.

Low pressure was central over Lake Superior, high over New Brunswick.

January 15, 1909.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 3,250 m.; at maximum altitude, 5,090 m.

The sky was nearly covered with St.-Cu. moving from the west until 8:45 a. m., from the west-northwest thereafter. Light fog prevailed until 8:17 and after 9 a. m.; dense fog at intervals from 8:17 until 9 a. m. In ascending the head kite entered the St.-Cu. at 9:04, and emerged therefrom in descending at 11:13 a. m.

Very high pressure was central over Winnipeg, and low pressure over the Gulf of St. Lawrence.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909. Jan. 16.	Mm	° C.	%		Meters p. s.	Meters.	Mm.	° C.	%		Meters p. s.
7:50 a. m.	723.9	— 6.2	100	ene.	9.4	526	723.9	— 6.2	100	ene.	9.4
7:55 a. m.	723.9	— 6.8	100	ene.	7.2	925	688.0	— 6.0	......	e.	....
8:18 a. m.	724.0	— 7.1	100	ene.	7.2	1,512	638.0	— 9.0	......	ese.	....
8:27 a. m.	724.0	— 6.7	98	ene.	8.5	1,556	634.4	— 8.9	......	ese.	....
8:42 a. m.	724.1	— 7.1	100	ene.	9.8	1,814	614.0	— 1.1	......	ese.	....
8:56 a. m.	724.2	— 7.1	100	e.	9.4	2,574	556.7	— 3.0	......	se.	....
10:10 a. m.	723.9	— 8.3	100	e.	8.5	2,574	556.7	— 4.1	......	se.	....
10:46 a. m.	723.9	— 8.4	100	e.	8.5	2,181	585.5	— 8.5	......	se.	....
10:49 a. m.	723.9	— 8.4	100	e.	8.0	1,785	615.8	— 7.2	......	ese.	....
10:58 a. m.	723.9	— 8.4	100	e.	8.0	1,582	636.2	— 6.4	......	ese.	....
11:05 a. m.	723.9	— 8.4	100	e.	8.5	1,089	678.2	— 8.0	......	e.	....
11:30 a. m.	723.6	— 8.7	100	e.	8.5	918	688.0	— 7.5	......	e.	....
11:48 a. m.	723.5	— 8.8	100	e.	8.0	526	723.5	— 8.8	100	e.	8.0
Jan. 18.											
10:07 a. m.	722.4	— 4.1	75	nw.	10.7	526	722.4	— 4.1	75	nw.	10.7
10:14 a. m.	722.7	— 4.6	74	nw.	11.6	968	683.4	— 8.7	......	nw.	....
10:18 a. m.	722.8	— 4.4	74	nw.	12.5	1,240	659.6	— 4.4	......	nnw.	....
10:30 a. m.	723.1	— 4.4	74	nw.	12.5	1,060	675.4	— 8.3	......	nw.	....
11:40 a. m.	722.8	— 4.4	74	nw.	17.9	526	722.8	— 4.4	74	nw.	17.9
Jan. 19.											
7:30 a. m.	723.6	—13.9	76	ese.	4.9	526	723.6	—13.9	76	ese.	4.9
7:40 a. m.	723.5	—13.3	72	ese.	4.5	940	....	— 4.4	......	sw.	....
8:22 a. m.	723.8	—12.2	68	ese.	4.9	1,322	653.8	8.9	......	wsw.	....
8:27 a. m.	723.3	—11.9	67	ese.	4.9	1,808	614.9	4.0	......	w.	....
8:48 a. m.	723.1	—11.4	70	ese.	5.4	2,146	589.8	5.2	......	w.	....
9:08 a. m.	723.0	—10.8	76	se.	4.9	2,821	542.0	0.0	......	w.	....
9:35 a. m.	722.9	—10.2	78	se.	4.9	3,205	516.4	— 3.4	......	w.	....
10:00 a. m.	722.6	—10.0	78	se.	4.9	4,279	450.7	— 9.5	......	w.	....
10:43 a. m.	722.2	— 8.5	78	se.	4.9	3,348	508.5	— 3.5	......	w.	....
11:06 a. m.	722.1	— 7.6	78	se.	2.7	2,810	544.0	0.8	......	w.	....
11:40 a. m.	721.6	— 6.9	73	se.	3.1	1,791	616.4	7.9	......	w.	....
11:50 a. m.	721.5	— 6.6	63	se.	3.1	1,411	645.8	5.0	......	w.	....
11:59 a. m.	721.4	— 6.2	64	se.	3.6	954	683.5	0.5	......	sw.	....
12:04 p. m.	721.4	— 7.5	68	se.	4.5	526	721.4	— 7.5	68	se.	4.5
Jan. 20.											
7:32 a. m.	720.1	0.0	85	nw.	8.0	526	720.1	0.0	85	nw.	8.0
7:38 a. m.	720.1	0.3	79	nw.	8.0	899	687.6	3.4	......	wnw.	....
8:46 a. m.	720.7	0.8	77	nw.	9.4	1,195	663.8	7.3	......	nw.	....
9:21 a. m.	720.9	0.7	80	nw.	10.3	1,371	649.9	3.8	......	nw.	....
11:05 a. m.	721.5	0.8	77	nnw.	8.0	1,085	673.6	7.6	......	nw.	....
11:25 a. m.	721.5	1.1	77	nnw.	6.7	893	689.6	6.6	......	wnw.	....
11:29 a. m.	721.5	1.4	76	nnw.	6.7	526	721.5	1.4	76	nnw.	6.7

January 16, 1909.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 6,300 m.; at maximum altitude, 3,500 m.

The sky was covered with Nb. moving from the east. Snow fell during the entire flight.

A high was central over the St. Lawrence and a low over Alabama.

January 18, 1909.—One kite was used; lifting surface, 6.3 sq. m. Wire out, 1,000 m., at maximum altitude.

The sky was cloudless during the flight.

Pressure was high over Ontario and low over southeastern New Brunswick.

January 19, 1909.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 6,200 m., at maximum altitude.

From 1/10 to 4/10 Ci. moving from the west until 10 a. m. and from 5/10 to 7/10 A.-St. thereafter.

A high was central over the Atlantic coast States and a low over Lake Superior.

January 20, 1909.—Five kites were used; lifting surface 31.5 sq. m. Wire out, 6,000 m.; at maximum altitude, 3,500 m.

From 3/10 to 8/10 Ci. moving from the northwest during the flight.

High pressure was central over West Virginia, and low pressure over Alberta, with a moderate depression over the lower St. Lawrence.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.					Meters						Meters
Jan. 21.	Mm.	° C.	%		p. s.	Meters.	Mm.	° C.	%		p. s.
7:11 a. m..	721.4	3.4	70	s.	3.0	526	721.4	3.4	70	s.	3.0
7:30 a. m..	721.6	3.6	71	s.	3.0	879	691.2	8.3	......	wsw.	....
8:20 a. m..	721.8	4.0	78	s.	3.9	1,028	679.2	9.6	......	w.	....
8:29 a. m..	721.8	3.9	69	s.	3.0	1,392	649.9	7.1	......	w.	....
10:03 a. m..	722.0	6.4	60	s.	2.2	1,181	667.4	9.8	......	w.	....
10:31 a. m..	722.1	7.8	60	s.	1.8	818	697.2	11.4	......	w.	....
10:34 a. m..	722.1	7.4	62	s.	1.8	526	722.1	7.4	62	s.	1.8
Jan. 22.											
7:18 a. m..	721.7	8.6	72	w.	5.4	526	721.7	8.6	72	w.	5.4
7:34 a. m..	721.9	8.6	73	w.	4.5	645	711.7	12.9	......	w.	....
9:30 a. m..	722.6	10.5	68	w.	5.8	1,122	672.8	11.6	......	nw.	....
10:29 a. m..	722.6	12.2	58	w.	4.0	890	690.6	13.5	......	nw.	......
10:57 a. m..	722.6	13.3	55	w.	2.7	526	722.6	13.3	55	w.	2.7
Jan. 23.											
7:20 a. m..	719.8	11.1	77	ssw.	6.3	526	719.8	11.1	77	ssw.	6.3
7:30 a. m..	719.8	11.4	77	ssw.	7.2	929	686.0	11.5	......	wsw.	....
7:40 a. m..	719.8	11.7	75	ssw.	6.3	1,150	668.2	11.8	......	w.	....
7:56 a. m..	719.8	11.7	75	ssw.	6.3	1,478	642.7	9.2	......	w.	....
8:58 a. m..	719.8	13.2	68	sw.	5.4	2,337	578.1	1.9	......	wsw.	....
9:34 a. m..	719.8	13.9	66	wsw.	4.9	3,098	524.9	− 5.5	......	wsw.	....
10:10 a. m..	719.8	14.4	63	sw.	3.1	3,599	492.6	− 8.7	......	sw.	....
10:43 a. m..	719.8	13.9	66	w.	4.9	2,662	554.5	− 2.9	......	sw.	....
11:03 a. m..	719.8	12.2	73	w.	4.5	1,976	603.7	2.8	......	wsw.	....
11:17 a. m..	719.6	12.2	76	wsw.	4.5	1,604	632.8	7.5	......	sw.	....
11:25 a. m..	719.5	12.2	76	w.	4.5	1,224	662.3	11.3	......	wsw.	....
11:38 a. m..	719.4	12.8	76	sw.	4.9	952	684.0	13.8	......	wsw.	....
11:48 a. m..	719.4	12.8	75	sw.	4.9	526	719.4	12.8	75	sw.	4.9

January 21, 1909.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 2,500 m.; at maximum altitude, 1,700 m.

Dense haze prevailed throughout the flight. Few Ci.-St. moving from the west near the northern and eastern horizon.

An area of high pressure, central off the New Jersey coast, covered the eastern part of the United States, and a low was over Oklahoma.

January 22, 1909.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 2,000 m., at maximum altitude.

A few A.-St. on the north and northeast horizon.

A high was central over Virginia and a low over Montana.

January 23, 1909.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 6,300 m.; at maximum altitude, 5,500 m.

Ci.-St., A.-St., and A.-Cu., moving from the west, covered 6/10 of the sky until 9 a. m. St.-Cu., moving from the west-southwest, appeared at 9:30 a. m., and the cloudiness increased to 9/10. The sky was overcast with A.-St. and St.-Cu. from 10 to 11 a. m., and thereafter with St. moving from the west-southwest. Light rain fell at intervals after 11:07 a. m. Broken St.-Cu. hid the head kite at intervals from 9:53 to 10:03, and from 10:19 to 10:23 a. m.

Pressure was high over the Atlantic coast. Low pressure was central over Colorado.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909. Jan. 25.	Mm.	° C.	%		Meters p. s.	Meters.	Mm.	° C.	%		Meters p. s.
7:39 a. m.	715.3	9.4	33	wnw.	9.8	526	715.3	9.4	33	wnw.	9.8
7:46 a. m.	715.3	9.4	32	wnw.	10.8	928	681.5	8.4	......	w.	....
7:55 a. m.	715.3	9.2	31	wnw.	11.6	1,245	655.8	6.7	......	wnw.	....
8:22 a. m.	715.3	9.4	26	wnw.	10.7	1,494	636.8	8.9	......	wnw.	....
9:57 a. m.	715.7	11.0	23	wnw.	8.5	2,077	593.4	3.7	......	wnw.	....
10:08 a. m.	715.7	10.9	28	wnw.	6.7	1,879	607.1	6.1	......	wnw.	....
10:30 a. m.	715.6	10.5	30	wnw.	4.5	1,747	617.0	2.7	......	wnw.	....
11:00 a. m.	715.6	10.1	32	nw.	8.6	1,272	653.8	6.1	......	wnw.	....
11:11 a. m.	715.6	10.4	35	nw.	4.0	788	693.5	9.1	......	nw.	....
11:15 a. m.	715.6	10.6	35	nw.	4.0	526	715.6	10.6	35	nw.	4.0
Jan. 26.											
8:27 a. m.	715.4	1.1	44	nw.	16.1	526	715.4	1.1	44	nw.	16.1
8:36 a. m.	715.4	0.7	49	wnw.	17.0	861	686.1	− 3.0	......	nw.	....
8:47 a. m.	715.8	0.6	49	wnw.	16.1	1,050	670.1	− 5.6	......	nw.	....
9:11 a. m.	716.2	0.6	54	wnw.	15.2	1,682	619.0	− 6.8	......	nw.	....
9:30 a. m.	716.2	1.1	53	wnw.	12.5	1,975	595.8	−10.5	......	nw.	....
9:52 a. m.	716.2	1.2	63	wnw.	14.3	2,659	544.6	−16.3	......	nw.	....
10:29 a. m.	716.3	1.7	54	wnw.	14.8	2,029	591.8	−11.1	......	nw.	....
11:00 a. m.	716.4	2.2	39	wnw.	18.4	1,587	630.9	− 6.4	......	nw.	....
11:14 a. m.	716.3	2.3	46	wnw.	13.9	1,106	666.1	− 5.0	......	nw.	....
11:22 a. m.	716.3	2.7	35	wnw.	15.6	849	688.1	− 2.1	......	nw.	....
11:28 a. m.	716.2	2.6	36	nw.	16.1	526	716.2	2.6	36	nw.	16.1
Jan. 27.											
8:15 a. m.	710.9	1.1	72	ssw.	11.6	526	710.9	1.1	72	ssw.	11.6
8:21 a. m.	710.8	1.1	72	ssw.	11.2	789	688.0	2.0	......	sw.	....
8:35 a. m.	710.6	1.1	53	ssw.	8.9	1,211	652.3	− 0.9	......	wsw.	....
9:18 a. m.	709.9	2.2	39	sw.	5.4	1,678	614.4	− 5.0	......	w.	....
9:40 a. m.	709.7	2.3	37	w.	5.8	2,071	584.2	− 7.5	......	w.	....
10:02 a. m.	709.5	2.2	32	w.	8.5	2,777	532.7	−18.1	......	w.	....
10:23 a. m.	709.0	3.3	37	w.	8.5	3,128	508.5	−16.0	......	w.	....
10:41 a. m.	708.8	4.2	38	w.	8.0	2,075	583.2	− 9.3	......	w.	....
11:07 a. m.	708.3	4.9	34	w.	7.2	1,792	604.4	− 6.5	......	w.	....
11:24 a. m.	707.7	5.3	36	w.	7.6	1,395	635.2	− 3.5	......	w.	....
11:33 a. m.	707.5	5.7	33	w.	7.6	1,063	662.0	− 1.0	......	w.	....
11:43 a. m.	707.0	5.4	35	w.	6.7	794	684.0	1.4	......	w.	....
11:48 a. m.	706.8	5.4	34	w.	7.6	526	706.8	5.4	34	w.	7.6

January 25, 1909.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 4,500 m., at the maximum altitude.

The clouds diminished from 7/10 Ci. at the beginning to 4/10 Ci. by the end of the flight. A few St.-Cu. after 9:27 a. m. All clouds were moving from the west.

An extensive area of high pressure was central over eastern Nebraska and pressure was low over Quebec.

January 26, 1909.—Three kites were used; lifting surface, 12.8 sq. m. Wire out, 5,500 m.; at maximum altitude, 5,080 m.

A few St.-Cu. moving from the northwest until 9 a. m.

Low pressure was central off the Maine coast, high pressure over Missouri.

January 27, 1909.—Three kites were used; lifting surface, 15.4 sq. m Wire out, 6,300 m., at maximum altitude.

St.-Cu. moving from the west diminished in amount from 9/10 at the beginning to a few at the close of the flight.

A low was central over Ontario and a high over the lower Mississippi Valley.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1901. Jan. 28.	Mm.	° C.	%		Meters p. s.	Meters.	Mm.	° C.	%		Meters p. s.
1:14 p. m..	712.2	0.7	65	nw.	13.0	526	712.2	0.7	65	nw.	13.0
1:37 p. m..	712.1	1.3	70	nw.	11.6	918	678.5	− 3.8	......	nw.	....
1:45 p. m..	712.1	1.5	62	nw.	10.7	1,077	664.5	− 1.4	......	nnw.	....
1:57 p. m..	712.1	1.6	66	nw.	10.3	1,387	639.2	− 2.1	......	nnw.	....
2:18 p. m..	712.1	2.2	65	nw.	9.4	1,962	594.2	− 4.9	......	nnw.	....
4:01 p. m..	711.8	2.7	64	nw.	12.5	1,515	629.3	1.5	......	nnw.	....
4:23 p. m..	711.4	2.8	60	nw.	11.2	2,028	668.5	3.3	......	nw.	....
4:33 p. m..	711.4	2.7	62	nw.	12.1	818	686.5	0.5	......	nw.	....
4:40 p. m..	711.4	2.7	60	nw.	12.1	526	711.4	2.7	60	nw.	12.1
Jan. 29.											
7:40 a. m..	705.5	− 1.8	61	ese.	9.8	526	705.5	− 1.8	61	ese.	9.8
7:52 a. m..	705.2	− 1.9	60	se.	8.5	1,073	658.7	3.1	......	ssw.	....
8:07 a. m..	705.1	− 2.3	68	ese.	9.4	1,664	612.0	− 0.2	......	sw.	....
8:26 a. m..	705.0	− 2.7	76	ese.	8.9	1,951	590.3	− 2.8	......	ssw.	....
8:51 a. m..	704.8	− 2.8	77	ese.	10.7	2,191	572.6	− 0.9	......	ssw.	....
9:13 a. m..	703.8	− 2.8	88	ese.	10.3	2,291	564.7	− 0.9	......	ssw.	....
9:15 a. m..	703.8	− 2.8	88	ese.	10.3	526	703.8	− 2.8	88	ese.	10.3
Jan. 30.											
9:54 a. m..	697.5	− 6.4	78	wnw.	15.2	526	697.5	− 6.4	78	wnw.	15.2
10:00 a. m..	697.7	− 6.4	78	wnw.	18.0	837	670.8	− 9.8	......	wnw.	....
10:32 a. m..	697.9	− 6.7	71	wnw.	18.0	1,296	631.6	−13.3	......	wnw.	....
10:41 a. m..	697.9	− 6.9	73	wnw.	17.9	1,472	617.2	−10.8	......	wnw.	....
11:04 a. m..	698.0	− 6.9	85	wnw.	15.2	1,516	613.6	−11.3	......	wnw.	....
11:26 a. m..	698.1	− 7.2	85	wnw.	15.6	1,449	617.1	−14.8	......	wnw.	....
11:44 a. m..	698.1	− 7.2	84	wnw.	14.3	1,074	650.1	−13.8	......	nw.	....
11:54 a. m..	698.2	− 7.2	84	wnw.	14.3	841	670.3	−11.1	......	nw.	....
12:02 p. m.	698.2	− 7.2	84	wnw.	16.1	526	698.2	− 7.2	84	wnw.	16.1

January 28, 1909.—Five kites were used; lifting surface, 30.6 sq. m. Wire out, 6,350 m., at maximum altitude, 3,000.

About 5/10 Ci.-St. moving from the northwest at the beginning of the flight. These gradually increased in thickness and extent, until at the close of the flight, the sky was practically overcast. Solar halos from 1:37 to 2:40 p. m., and from 3:35 p. m. to the close of the flight.

At 8 a. m. pressure was relatively high from the Gulf of Mexico northward to the lower Lake region. Areas of low pressure were central over the Gulf of St. Lawrence and over Nebraska.

January 29, 1909.—Two kites were used; lifting surface, 11.7 sq. m. Wire out, 5,275 m., at maximum altitude.

At the beginning the sky was overcast with St. moving from the southwest. Sleet fell after 7:47 a. m. The head kite passed into the clouds at 8:22 a. m., altitude about 1,840 m., and was obscured at all greater altitudes.

Very low pressure was central over Illinois. Pressure was comparatively high over northern New York.

January 30, 1909.—Two kites were used; lifting surface, 9.1 sq. m. Wire out, 3,500 m., at maximum altitude.

About 8/10 St. moving from north-northwest were visible until 11:40 a. m. and 8/10 Nb. from the northwest thereafter. Light snow began at 11:40 a. m. and continued until the close of the flight.

A low was central off Cape Cod and high over Manitoba.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909. Feb. 1.	Mm.	° C.	%		Meters p. s.	Meters.	Mm.	° C.	%		Meters p. s.
1:56 p.m.	723.6	− 5.8	55	nw.	13.4	526	723.6	− 5.8	55	nw.	13.4
1:59 p.m.	723.6	− 5.8	55	nw.	13.4	772	701.1	− 8.7	......	nw.	....
2:22 p.m.	723.6	− 5.6	52	nw.	13.4	942	685.9	− 8.6	......	nw.	....
2:32 p.m.	723.6	− 5.6	52	nw.	11.6	1,090	673.2	− 8.5	......	nw.	....
2:43 p.m.	723.6	− 5.4	52	nw.	11.6	1,619	629.5	− 5.6	......	nnw.	....
2:57 p.m.	723.6	− 5.4	47	nw.	13.4	2,109	591.5	− 5.0	......	nnw.	....
3:56 p.m.	723.0	− 4.6	58	nw.	17.9	1,972	601.5	− 6.8	......	nnw.	....
4:15 p.m.	723.1	− 4.4	74	nw.	15.2	1,502	638.9	− 2.4	......	nnw.	....
4:22 p.m.	723.1	− 4.6	74	nw.	15.2	1,341	651.6	− 2.6	......	nnw.	....
4:29 p.m.	723.2	− 4.7	48	nw.	12.5	1,069	675.7	− 2.0	......	nw.	....
4:32 p.m.	723.2	− 4.8	47	nw.	12.5	824	696.1	− 7.4	......	nw.	....
4:46 p.m.	723.3	− 4.9	57	nw.	10.8	526	723.3	− 4.9	57	nw.	10.8
Feb. 2.											
7:20 a.m.	720.3	− 5.1	69	wnw.	9.4	526	720.3	− 5.1	69	wnw.	9.4
7:29 a.m.	720.3	− 5.4	79	wnw.	9.8	942	688.2	− 5.1	......	wnw.	....
8:38 a.m.	720.3	− 4.2	67	wnw.	8.5	1,263	656.5	− 0.1	......	wnw.	....
9:33 a.m.	720.4	− 3.1	69	wnw.	7.6	1,926	604.1	− 1.6	......	wnw.	....
10:13 a.m.	720.3	− 1.1	61	wnw.	8.0	1,585	630.5	− 1.1	......	wnw.	....
10:25 a.m.	720.3	− 0.6	58	wnw.	7.6	1,341	650.2	0.3	......	wnw.	....
10:40 a.m.	720.2	0.0	66	wnw.	7.6	1,007	678.1	− 3.1	......	wnw.	....
10:52 a.m.	720.1	0.6	50	wnw.	7.2	526	720.1	0.6	50	wnw.	7.2
Feb. 3.											
7:26 a.m.	716.1	0.3	66	wsw.	4.5	526	716.1	0.3	66	wsw.	4.5
7:38 a.m.	716.1	0.8	72	wsw.	4.5	877	685.6	1.0	......	w.	....
8:06 a.m.	716.0	1.7	68	wsw.	4.9	1,197	658.6	− 1.9	......	w.	....
8:15 a.m.	716.0	1.7	68	wsw.	4.9	1,711	617.4	− 4.7	......	w.	....
9:45 a.m.	716.2	0.4	69	wnw.	3.6	526	716.2	0.4	69	wnw.	3.6
Feb. 4.											
7:26 a.m.	712.4	4.9	50	sw.	4.5	526	712.4	4.9	50	sw.	4.5
7:40 a.m.	712.4	5.2	50	sw.	4.5	930	678.1	3.9	52	w.	....
8:00 a.m.	712.4	4.6	53	sw.	4.5	1,286	652.7	1.6	60	wnw.	....
8:10 a.m.	712.4	5.1	54	sw.	5.4	1,922	600.2	3.0	41	wnw.	....
8:50 a.m.	712.4	6.8	47	sw.	4.9	2,554	555.0	− 0.3	30	wnw.	....
9:20 a.m.	712.3	7.6	44	sw.	4.9	3,391	499.6	− 3.8	41	wnw.	....
10:10 a.m.	712.2	7.8	47	sw.	4.5	2,784	539.6	0.0	51	wnw.	....
10:43 a.m.	712.0	8.7	42	sw.	4.9	1,832	607.3	4.2	18	wnw.	....
11:18 a.m.	711.7	9.8	38	wsw.	6.7	526	711.7	9.8	38	wsw.	6.7

February 1, 1909.—Three kites were used; lifting surface, 18.0 sq. m. Wire out, 4,700 m.; at maximum altitude, 3,000 m.

The sky was cloudless during the greater part of the flight. A few Ci.-St. appeared on the horizon just before the flight ended.

An extensive high was central over Kentucky and pressure was relatively low over western Ontario and New Brunswick.

February 2, 1909.—Three kites were used; lifting surface, 14.5 sq. m. Wire out, 5,000 m., at maximum altitude.

A few Ci.-St. were visible moving from the west-northwest.

A low was central over the lower St. Lawrence and a high over Mississippi.

February 3, 1909.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 3,500 m., at maximum altitude.

About 2/10 Ci.-St. moving from the west during the flight.

Pressure was high over the Gulf coast and low over New Brunswick.

February 4, 1909.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 6,200 m., at maximum altitude.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
Feb. 4. 2d flight.	Mm.	° C.	%		Meters p. s.	Meters.	Mm.	° C.	%		Meters p. s.
11:59 a. m..	711.8	10.6	89	sw.	6.8	526	711.8	10.6	89	sw.	6.8
12:15 p. m..	711.2	10.4	87	wsw.	7.6	967	674.8	6.4	......	w.	....
12:30 p. m..	711.0	11.2	89	wsw.	7.6	1,537	629.2	8.8	......	w.	....
12:59 p. m..	710.7	11.3	40	wsw.	8.0	2,253	576.4	3.7	......	wnw.	....
1:26 p. m..	710.5	11.4	42	wsw.	7.6	3,063	521.2	— 1.4	......	wnw.	....
1:50 p. m..	710.3	11.4	50	s.	2.7	3,250	509.4	— 1.1	......	wnw.	....
2:18 p. m..	710.8	10.7	50	sse.	2.2	3,007	525.2	0.5	......	wnw.	....
2:46 p. m..	710.3	11.4	42	sse.	5.4	2,566	554.7	2.9	......	w.	....
3:27 p. m..	710.8	12.6	36	sse.	4.5	1,589	625.2	6.8	......	wsw.	....
3:45 p. m..	710.8	12.5	40	sse.	3.1	1,107	662.6	9.7	......	wsw.	....
3:54 p. m..	710.8	11.7	41	s.	4.5	526	710.8	11.7	41	s.	4.5
Feb. 5.											
7:18 a. m..	710.8	9.7	65	sw.	4.9	526	710.8	9.7	65	sw.	4.9
7:27 a. m..	710.8	10.0	65	sw.	5.4	953	675.2	9.4	......	w.	....
7:50 a. m..	711.0	11.7	63	sw.	4.9	1,250	651.5	5.8	......	w.	....
8:02 a. m..	711.0	11.7	58	sw.	4.9	1,881	602.9	1.5	......	w.	....
8:22 a. m..	710.9	11.9	57	sw.	5.8	2,312	571.4	— 1.5	......	w.	....
8:41 a. m..	710.8	12.2	56	ssw.	5.4	2,713	543.8	— 2.5	......	wsw.	....
9:14 a. m..	710.6	12.8	55	ssw.	4.0	3,583	489.8	— 8.6	......	wsw.	....
9:48 a. m..	710.5	13.4	56	sw.	4.0	2,782	539.8	— 1.0	......	wsw.	....
10:07 a. m..	710.4	14.0	53	sw.	5.4	2,402	565.4	— 1.0	......	sw.	....
10:28 a. m..	710.8	14.4	52	sw.	4.0	1,861	604.8	4.1	......	sw.	....
10:39 a. m..	710.8	14.8	48	sw.	3.6	1,447	636.0	6.9	......	sw.	....
10:49 a. m..	710.2	14.2	54	sw.	4.0	924	677.2	9.6	......	sw.	....
10:55 a. m..	710.2	13.7	51	sw.	3.6	526	710.2	13.7	51	sw.	3.6
Feb. 6.											
7:25 a. m..	701.8	7.2	93	sw.	9.4	526	701.8	7.2	93	sw.	9.4
7:34 a. m..	701.4	8.2	85	ssw.	9.8	911	....	7.4	......	wsw.	....
8:05 a. m..	701.7	9.4	74	wsw.	12.5	1,572	617.7	0.4	......	w.	....
9:11 a. m..	703.4	9.4	67	w.	11.6	1,888	598.4	— 2.4	......	w.	....
9:50 a. m..	708.7	8.9	48	w.	15.2	2,190	572.8	— 4.6	......	w.	....
11:13 a. m.	705.0	7.8	45	wnw.	15.2	1,467	627.6	— 2.6	......	wnw.	....
11:44 a. m..	705.0	7.5	46	wnw.	18.8	907	672.8	3.1	......	wnw.	....
11:52 a. m..	705.0	7.6	44	wnw.	19.7	526	705.0	7.6	44	wnw.	19.7

Second flight: Three kites were used; lifting surface, 18.9 sq. m. Wire out, 6,300 m., at maximum altitude.

About 7/10 Ci.-St. moving from the northwest at the beginning of the first flight. Cloudiness decreased gradually to about 3/10 at midday, but increased again during the afternoon to about 8/10. Near the close of the second flight the clouds changed from Ci.-St. to Ci.-Cu. and later to A.-Cu. A solar corona from 9:30 to 10:40 a. m. Light haze prevailed.

At 8 a. m. high pressure covered the South Atlantic and Gulf States, and a moderate area of low pressure was central over the Dakotas.

February 5, 1909.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 6,200 m., at maximum altitude.

From 2/10 to 9/10 A.-St. moving from the west-southwest during the flight. From 1/10 to 4/10 St.-Cu. from the west were visible from 8:17 to 8:39 a. m.

A low was central over Lake Michigan and a high off the south Atlantic coast.

February 6, 1909.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 5,800 m.; at maximum altitude, 4,800 m.

St.-Cu., moving from the west-southwest at the beginning, from the west after 7:30 a. m., increased from 2/10 to 8/10 by 8 a. m., and diminished after 9 a. m. to 2/10 by noon. Rain fell from 8 to 8:05 a. m. The head kite was in clouds at short intervals from 8 to 9:30 a. m.

Very low pressure, central north of Lake Ontario, covered the Eastern States.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.					*Meters*						*Meters*
Feb. 8.	*Mm.*	° *C.*	*%*		*p. s.*	*Meters.*	*Mm.*	° *C.*	*%*		*p. s.*
8:55 a. m.	717.8	— 3.5	91	nw.	11.2	526	717.8	— 3.5	91	nw.	11.2
9:06 a. m.	717.8	— 2.5	76	nw.	11.2	918	682.7	— 3.8	......	nw.	....
9:27 a. m.	717.5	— 1.7	72	nw.	11.2	1,230	656.4	— 3.5	......	nw.	....
9:32 a. m.	717.5	— 1.6	70	nw.	10.8	1,629	624.2	— 5.4	......	nnw.	....
9:47 a. m.	717.6	— 1.7	78	nw.	9.4	2,116	586.8	— 6.6	......	nnw.	....
10:33 a. m.	717.7	— 0.6	69	nw.	12.5	2,660	547.4	— 9.8	......	nnw.	....
10:50 a. m.	717.7	— 0.1	71	nw.	18.4	2,461	561.2	— 7.1	......	nnw.	....
12:10 p. m.	717.6	1.1	75	wnw.	8.9	1,441	639.5	— 5.8	......	nw.	....
12:25 p. m.	717.4	1.4	58	wnw.	9.8	958	679.7	— 2.6	......	nw.	....
12:32 p. m.	717.4	1.7	57	wnw.	10.3	526	717.4	1.7	57	wnw.	10.8
Feb. 9.											
7:28 a. m.	717.5	0.6	68	ese.	5.4	526	717.5	0.6	68	ese.	5.4
8:05 a. m.	717.8	1.1	60	se.	6.7	1,013	676.0	5.2	......	s.	....
8:20 a. m.	717.7	1.7	55	ese.	7.6	1,718	619.4	— 1.4	......	sw.	....
8:42 a. m.	717.6	1.7	66	ese.	8.9	2,423	566.2	— 8.6	......	sw.	....
9:14 a. m.	717.6	2.8	63	ese.	7.2	2,698	546.5	— 9.4	......	sw.	....
9:42 a. m.	717.6	1.1	62	ese.	6.8	3,350	501.2	—11.6	.....	sw.	....
10:15 a. m.	717.5	0.6	68	ese.	4.5	2,514	558.8	— 7.1	......	sw.	....
10:31 a. m.	717.6	0.3	77	ese.	5.4	2,217	580.0	— 5.8	......	sw.	....
10:47 a. m.	717.7	0.0	78	se.	2.2	1,726	617.4	— 4.4	......	ssw.	....
11:00 a. m.	717.6	0.5	76	se.	3.6	1,286	656.5	— 1.6	......	ssw.	....
11:10 a. m.	717.6	— 1.0	87	se.	4.5	889	685.8	— 0.7	......	ssw.	....
11:15 a. m.	717.5	— 1.4	94	se.	4.5	526	717.5	— 1.4	94	se.	4.5
Feb. 10.											
9:20 a. m.	699.8	10.7	97	s.	8.9	526	699.8	10.7	97	s.	8.9
9:26 a. m.	699.8	10.6	98	s.	5.4	899	....	8.7	......	sw.	....
9:39 a. m.	699.8	6.1	100	nne.	5.8	1,878	630.8	6.1	......	ssw.	....
9:55 a. m.	699.8	4.9	94	nw.	9.8	1,947	587.8	3.3	......	sw.	....
10:05 a. m.	699.8	4.1	97	nw.	9.8	526	699.8	4.1	97	nw.	9.8

February 8, 1909.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 4,900 m., at the maximum altitude.

The sky was cloudless during the flight.

An extensive area of low pressure was central over Colorado and pressure was high over the South Atlantic and eastern Gulf States.

February 9, 1909.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 6,200 m.; at maximum altitude, 5,230 m.

St. moving from the southwest covered the sky until 8:30 and after 9:20 a. m. A.-St. moving probably from the southwest appeared at 8:30, increased to 8/10 by 8:50, and gave way to St. by 9:20 a. m. Snow fell after 10:43 a. m. The head kite was hidden in clouds from 9:16 to 10:14 a. m.

A low was central over Iowa. High pressure was central north of Lake Ontario.

February 10, 1909.—Two kites were used; lifting surface, 9.1 sq. m. Wire out, 2,450 m., at maximum altitude.

About 2/10 St.-Cu. moving from the southwest until 9:26 a. m. From 7/10 to 10/10 St. moving from the southwest until 9:50 a. m., when the direction changed rapidly to northwest. Light rain began at 10:02 and ended at 11:55 a. m.

A low was central north of Lake Huron, and a high off the Texas coast.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.											
Feb. 11.	*Mm.*	° *C.*	*%*		*Meters p. s.*	*Meters.*	*Mm.*	° *C.*	*%*		*Meters p. s.*
7:11 a. m.	711.6	— 4.8	75	w.	10.3	526	711.6	— 4.8	75	w.	10.3
7:16 a. m.	711.6	— 4.8	75	w.	10.7	966	672.6	— 8.8	......	w.	....
7:25 a. m.	711.7	— 5.0	72	w.	8.9	1,385	636.9	—13.5	......	wnw.	....
8:00 a. m.	712.0	— 4.7	78	w.	6.7	1,768	606.0	—15.5	......	wnw.	....
8:48 a. m.	712.5	— 3.6	66	w.	8.0	1,398	636.9	—12.5	......	wnw.	....
8:57 a. m.	712.6	— 3.6	64	w.	8.5	1,002	670.6	— 8.0	......	w.	....
9:00 a. m.	712.6	— 3.6	63	w.	9.8	526	712.6	— 3.6	63	w.	9.8
Feb. 12.											
7:26 a. m.	722.0	— 0.7	33	sse.	5.8	526	722.0	— 0.7	33	sse.	5.8
7:36 a. m.	722.0	— 1.3	36	sse.	5.4	941	685.5	— 0.2	......	s.	....
7:50 a. m.	722.2	— 1.5	42	se.	4.9	1,200	663.8	1.0	......	sw.	....
8:00 a. m.	722.0	— 1.4	42	se.	6.3	1,437	644.3	— 0.2	......	sw.	....
8:16 a. m.	721.9	0.5	29	sse.	7.2	2,091	593.5	— 4.4	.....	wsw.	....
8:35 a. m.	722.2	1.1	27	sse.	7.2	2,717	548.1	—10.3	......	wsw.	....
8:54 a. m.	722.1	0.6	38	se.	6.8	3,169	516.6	—15.8	......	wsw.	....
9:20 a. m.	722.0	0.5	38	se.	6.7	3,685	482.4	—19.3	......	wsw.	....
9:45 a. m.	721.8	0.5	52	se.	5.8	2,992	528.4	—13.8	......	wsw.	....
9:50 a. m.	721.8	0.5	52	se.	7.2	526	721.8	0.5	52	se.	7.2
Feb. 13.											
7:29 a. m.	715.9	6.9	75	ssw.	6.3	526	715.9	6.9	75	ssw.	6.3
7:35 a. m.	715.9	7.1	75	ssw.	5.8	972	678.2	5.6	......	wsw.	....
8:06 a. m.	716.0	8.0	72	sw.	5.8	1,461	628.8	2.7	......	w.	....
8:20 a. m.	716.2	7.8	78	sw.	4.9	1,842	609.2	0.1	......	wnw.	....
8:32 a. m.	716.2	7.4	76	sw.	4.5	1,975	599.1	— 0.9	.....	wnw.	....
9:22 a. m.	716.5	8.1	75	sw.	4.0	526	716.5	8.1	75	sw.	4.0

February 11, 1909.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 4,000 m.; at the maximum altitude, 3,400 m.

Few St.-Cu., moving from the northwest, were present during the flight. The atmosphere was unusually clear.

A low, accompanied by general precipitation, was central somewhat north of the St. Lawrence Valley, and a moderate high pressure area covered the Gulf States.

February 12, 1909.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 6,200 m., at maximum altitude.

A.-Cu. moving from the west in amounts decreasing from 5/10 at 7:30 to 1/10 at 8 a. m. At 8:30 3/10 Ci.-St. moving from the west, and at 9:45 a.m. 2/10 A.-Cu.

High pressure was central over the south Atlantic coast. A trough of low pressure extended from Lake Superior to Oklahoma.

February 13, 1909.—Two kites were used; lifting surface, 12.6 sq. m. Wire out. 2,760 m., at maximum altitude.

The sky was covered with St. moving from the west. Light rain fell from 7:35 to 7:49 a. m. The head kite was obscured by clouds after 8:17 a. m.

A low was central over the lower St. Lawrence and a high off the south Atlantic coast.

RESULTS OF KITE FLIGHTS.

	On Mount Weather, Va., 526 m.					At different heights above sea.					
						t.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
Feb. 15.	Mm.	° C.	%		p. s.	Meters.	Mm.	° C.	%		Meters p. s.
1:04 p. m.	716.3	14.4	89	s.	11.2	526	716.3	14.4	89	s.	11.2
1:08 p. m.	716.3	14.4	89	s.	11.2	979	679.0	12.7	......	ssw.	....
1:24 p. m.	716.3	14.2	91	s.	9.8	1,449	641.7	9.3	......	ssw.	....
1:37 p. m.	716.3	13.9	94	s.	10.7	1,630	627.9	12.9	......	ssw.	....
2:28 p. m.	716.1	14.0	95	s.	[illegible]	2,476	567.2	7.4	......	sw.	....
3:08 p. m.	715.8	14.3	91	s.	7.6	2,235	583.0	10.0	......	ssw.	....
3:16 p. m.	715.7	14.4	91	s.	8.0	1,930	604.7	5.9	......	ssw.	....
4:00 p. m.	715.5	14.7	90	s.	8.9	1,293	653.3	11.4	......	ssw.	....
4:21 p. m.	715.5	14.9	89	s.	6.7	845	689.0	12.2	......	s.	....
4:35 p. m.	715.5	14.9	90	s.	8.9	526	715.5	14.9	90	s.	8.9
Feb. 16.											
11:01 a. m.	708.7	13.4	99	s.	7.6	526	708.7	13.4	99	s.	7.6
11:14 a. m.	708.6	13.7	97	s.	7.6	822	684.0	11.2	......	ssw.	....
11:34 a. m.	708.3	13.6	97	ssw.	7.6	1,137	658.2	9.0	......	ssw.	....
12:01 p. m.	708.0	15.9	95	ssw.	8.0	1,687	619.4	5.1	......	sw.	....
12:48 p. m.	707.3	16.1	74	ssw.	7.6	1,635	619.4	5.7	......	sw.	....
1:19 p. m.	706.8	16.6	73	s.	7.6	2,274	572.1	0.3	......	sw.	....
1:45 p. m.	706.3	16.2	78	s.	7.2	2,162	578.0	0.0	......	sw.	....
1:54 p. m.	706.1	16.0	75	s.	8.0	1,774	607.6	3.2	......	sw.	....
1:58 p. m.	706.1	13.9	88	ssw.	8.5	867	678.0	9.4	......	ssw.	....
2:15 p. m.	705.9	13.3	91	ssw.	8.0	526	705.9	13.3	91	ssw.	8.0
Feb. 17.											
1:28 p. m.	716.7	− 1.4	67	wnw.	16.1	526	716.7	− 1.4	67	wnw.	16.1
1:31 p. m.	716.7	− 1.7	56	wnw.	13.4	818	690.8	− 5.4	......	wnw.	....
2:16 p. m.	716.8	0.0	45	nw.	11.6	1,675	604.6	− 5.9	......	nw.	....
2:40 p. m.	716.8	0.0	45	nw.	13.4	2,557	553.4	−10.8	......	nw.	....
3:45 p. m.	717.0	1.1	35	nw.	10.7	3,172	510.0	−17.7	......	nw.	....
4:25 p. m.	717.2	1.6	37	nw.	7.6	4,423	430.7	−26.6	......	wnw.	....
5:46 p. m.	717.8	0.6	40	nw.	7.2	3,398	495.4	−18.7	......	wnw.	....
6:16 p. m.	718.0	− 0.2	40	nw.	3.6	2,837	533.6	−14.6	......	wnw.	....
6:49 p. m.	718.2	− 0.8	42	nw.	3.6	2,015	594.7	− 7.7	......	wnw.	....
7:20 p. m.	718.5	− 0.9	40	nw.	4.9	1,449	639.6	− 4.1	......	w.	....
7:32 p. m.	718.6	− 0.6	39	nw.	4.9	957	680.6	− 1.9	......	w.	....
7:41 p. m.	718.6	− 0.6	39	nw.	4.9	526	718.6	− 0.6	39	nw.	4.9

February 15, 1909.—Three kites were used; lifting surface, 14.5 sq. m. Wire out, 5,500 m.; at the maximum altitude, 4,850 m.

From 7/10 to 9/10 St. moving from the south during the flight. Through rifts in the lower clouds a layer of A.-St. moving from the southwest.

An extensive area of high pressure was central over the Dakotas. Pressure was relatively low over the Ohio Valley and east Gulf States, with centers over West Virginia and Mississippi.

February 16, 1909.—Four kites were used; lifting surface, 18.2 sq. m. Wire out, 5,000 m., at maximum altitude.

From 5/10 to 7/10 St. moving from the south-southwest, and from 1/10 to 2/10 St.-Cu. from the southwest during the flight. Light rain fell from 1:58 to 2:20 p. m. The head kite was obscured by clouds at intervals from 11:07 a. m. to 1:55 p. m.

Low pressure was central over West Virginia and high over Nebraska and the Gulf of St. Lawrence:

February 17, 1909.—Six kites were used; lifting surface, 36.6 sq. m. Wire out, 8,500 m.; at maximum altitude, 8,300 m.

The sky was cloudless during the flight.

An extensive area of high pressure was central over Mississippi and Alabama. Pressure was low over Nova Scotia.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.		° C.			Meters						Meters
Feb. 18.	Mm.		%		p. s.	Meters.	Mm.	° C.	%		p. s.
7:08 a. m..	720.7	0.4	61	w.	5.4	526	720.7	0.4	61	w.	5.4
7:36 a. m..	720.8	1.5	58	w.	4.5	1,012	678.5	— 1.9	......	w.	....
7:44 a. m..	720.8	1.7	46	w.	4.0	1,440	643.3	— 0.3	......	w.	....
8:09 a. m.	720.9	2.3	56	sw.	1.8	1,993	600.3	— 3.5	......	w.	....
8:54 a. m..	721.3	3.2	55	wsw.	4.9	2,617	555.0	— 7.4	......	wnw.	....
9:31 a. m..	721.3	3.3	60	wsw.	4.0	2,901	535.3	— 8.4	......	w.	....
9:52 a. m..	721.3	3.8	48	sw.	3.1	3,784	477.4	—13.6	......	w.	....
9:56 a. m..	721.3	3.9	44	sw.	2.7	3,847	473.5	—13.8	......	w.	....
10:28 a. m..	721.3	5.3	37	sw.	4.0	4,778	418.6	—18.7	......	w.	....
10:33 a. m..	721.3	5.6	41	sw.	3.6	4,812	416.7	—17.9	.....	w.	....
11:14 a. m..	721.1	6.9	35	se.	4.5	5,153	399.0	—20.3	......	w.	....
11:54 a. m..	720.6	7.2	33	sse.	5.4	4,634	428.4	—16.5	......	wsw.	....
12:08 p. m..	720.5	7.5	33	sse.	4.9	4,599	430.4	—14.9	......	wsw.	....
2:15 p. m..	719.0	10.0	39	se.	4.9	3,610	490.0	— 8.5	......	wsw.	....
2:31 p. m..	718.8	9.8	36	se.	5.4	3,168	517.6	— 8.0	.....	wsw.	....
2:36 p. m..	718.8	9.9	36	se.	5.4	2,896	535.8	— 8.4	......	wsw.	....
2:53 p. m..	718.7	9.4	34	sse.	4.5	2,302	576.7	— 4.9	......	wsw.	....
3:25 p. m..	718.6	9.4	32	s.	5.8	1,286	654.8	2.4	......	s.	....
3:33 p. m..	718.5	9.0	32	s.	5.8	854	690.5	5.5	....	s.	....
3:39 p. m..	718.5	9.3	32	sse.	5.8	526	718.5	9.3	32	sse.	5.8
Feb. 19.											
7:20 a. m..	712.7	— 0.6	77	se.	4.9	526	712.7	— 0.6	77	se.	4.9
7:37 a. m..	712.7	— 0.6	70	se.	4.5	1,278	649.0	2.3	......	s.	....
7:42 a. m..	712.7	— 0.6	70	se.	4.5	1,290	653.0	2.7	......	s.	....
8:58 a. m..	712.8	0.0	82	se.	4.9	526	712.8	0.0	82	s.	4.9
2d flight.											
1:09 p. m.	706.7	6.1	86	se.	7.6	526	706.7	6.1	86	se.	7.6
1:17 p. m..	706.6	6.1	85	se.	8.0	900	675.1	6.0	......	sse.	....
1:27 p. m..	706.3	6.3	85	se.	6.3	1,359	638.1	6.0	......	s.	....
1:45 p. m..	706.0	6.7	83	se.	6.3	1,597	619.6	4.0	......	s.	....
1:58 p. m..	705.7	6.9	83	se.	7.2	1,839	601.1	6.0	......	s.	....
2:28 p. m..	705.0	8.3	83	se.	3.6	2,318	566.2	— 0.3	......	s.	....
2:47 p. m..	704.6	8.6	84	se.	4.9	1,340	638.1	4.7	......	s.	....
3:38 p. m..	703.3	7.6	96	se.	5.8	953	667.7	6.5	......	s.	....
3:44 p. m..	703.2	7.8	96	se.	7.2	526	703.2	7.8	96	se.	7.2

February 18, 1909.—Seven kites were used; lifting surface, 44.1 sq. m. Wire out, 10,000 m., at maximum altitude.

From 3/10 to 8/10 clouds moving from the west during the flight. The clouds consisted of Ci.-St. during the early morning. Solar halos of 22° radius from 7:24 to 8:21 a. m. and from 1:44 to 2:55 p. m.

At 8 a. m. high pressure was central over North Carolina and a moderate low was central over Oklahoma.

February 19, 1909.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 3,000 m.; at maximum altitude, 1,200 m.

From 9/10 to 10/10 St. moving from the south. Light rain fell from 7:42 to 7:58 a. m. The head kite was in the clouds at 926 m. and at greater altitudes.

Second flight: Three kites were used; lifting surface, 12.8 sq. m. Wire out, 5,500 m., at maximun altitude.

About 2/10 A.-St. moving from the southwest until 2:06 p. m. From 6/10 to 10/10 St. moving from the west-southwest until 2:06 p. m. and from the south thereafter. Light rain began at 2:22 p. m. and continued during the remainder of the flight. The head kite was in the clouds from 2:10 to 3:10 p. m.

High pressure was central off the New England coast and low over Indiana.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity
1909. Feb. 20.	*Mm.*	° *C.*	%		*Meters p. s.*	*Meters.*	*Mm.*	° *C.*	%		*Meters p. s.*
8:30 a. m.	704.4	8.0	71	wnw.	15.2	526	704.4	8.0	71	wnw.	15.2
8:39 a. m.	704.7	2.8	72	wnw.	14.8	906	672.1	— 0.2	......	wnw.	....
9:05 a. m.	704.6	2.6	71	wnw.	17.0	1,395	631.9	— 4.5	......	wnw.	....
9:18 a. m.	704.9	2.6	71	wnw.	18.8	1,710	607.4	— 4.8	......	wnw.	....
9:36 a. m.	705.0	2.5	74	wnw.	15.6	1,988	586.4	— 7.4	......	wnw.	....
9:50 a. m.	705.0	2.5	74	wnw.	15.6	1,942	590.1	— 1.1	......	wnw.	....
10:01 a. m.	705.2	2.6	74	wnw.	15.2	2,263	567.0	— 2.0	......	wnw.	....
10:13 a. m.	705.8	2.7	74	wnw.	17.0	2,666	538.9	— 4.1	......	wnw.	....
10:45 a. m.	705.6	2.8	72	wnw.	16.1	8,251	500.4	— 7.2	......	wnw.	....
11:28 a. m.	706.4	8.3	65	wnw.	12.5	2,222	570.7	— 2.9	......	wnw.	....
11:37 a. m.	706.4	3.3	64	wnw.	18.9	1,834	599.4	— 6.6	......	wnw.	....
11:53 a. m.	706.4	3.6	63	wnw.	13.4	1,214	648.1	— 4.8	......	wnw.	....
12:23 p. m.	706.4	4.4	61	wnw.	12.5	797	688.1	0.8	......	wnw.	....
12:27 p. m.	706.4	5.0	59	wnw.	12.1	526	706.4	5.0	59	wnw.	12.1
Feb. 22.											
2:32 p. m.	718.8	5.0	88	se.	4.0	526	718.8	5.0	88	se.	4.0
2:51 p. m.	718.9	5.2	83	se.	5.4	765	698.1	3.0	......	se.	....
4:40 p. m.	719.4	5.0	92	se.	8.6	526	719.4	5.0	92	se.	8.6
Feb. 23.											
10:40 a. m.	718.5	4.4	100	sse.	10.7	526	718.5	4.4	100	sse.	10.7
10:52 a. m.	718.5	4.4	100	sse.	11.2	915	684.9	1.8	......	s.	....
11:07 a. m.	718.4	4.4	100	sse.	10.8	1,202	661.0	4.4	......	s.	....
11:18 a. m.	718.8	4.4	100	sse.	11.6	1,362	648.0	6.0	......	s.	....
11:34 a. m.	718.3	4.4	100	sse.	10.7	1,482	638.8	8.0	......	s.	....
11:55 a. m.	718.0	4.4	100	sse.	18.4	526	718.0	4.4	100	sse.	13.4

February 20, 1909.—Four kites were used; lifting surface, 18.2 sq. m. Wire out, 7,000 m.; at maximum altitude, 6,225 m.

The sky was overcast with St.-Cu. moving from the west-northwest until noon; after which cloudiness rapidly decreased to 3/10 by the end of the flight. The head kite entered the base of the St.-Cu. at 8:59 a. m., altitude 1,315 m., and was visible only at intervals, through rifts, until 11:53 a. m., when it descended below the cloud level. The marked difference in temperature between levels at 9:36 and at 9:50 a. m., at nearly the same altitude, was caused by clouds.

Very low pressure was central over Maine, and low pressure covered the United States.

February 22, 1909.—Three kites were used; lifting surface, 19.4 sq. m. Wire out, 1,000 m.; at the maximum altitude, 500 m.

The sky was overcast with St. moving from the southwest.

High pressure was central over eastern Pennsylvania. Low pressure was central over Colorado and eastern North Carolina.

February 23, 1909.—Two kites were used; lifting surface, 10.8 sq. m. Wire out, 2,600 m., at maximum altitude.

Dense fog and light rain prevailed.

High pressure was central over New England, low pressure over Missouri.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.					Meters						Meters
Feb. 24.	Mm.	° C.	%		p. s.	Meters.	Mm.	° C.	%		p. s.
1:01 p. m.	703.0	11.7	86	sw.	6.7	526	703.0	11.7	86	sw.	6.7
1:08 p. m.	703.0	11.7	86	sw.	7.6	873	674.4	9.6	......	wsw.	....
2:12 p. m.	702.8	12.2	75	sw.	8.5	1,463	627.5	7.0	......	wsw.	....
3:15 p. m.	702.8	10.8	77	wnw.	11.6	1,831	599.1	2.1	......	w.	....
4:05 p. m.	702.8	10.2	72	wnw.	7.2	1,626	614.2	2.0	......	w.	....
4:20 p. m.	702.8	10.4	83	wnw.	11.6	1,234	644.5	4.8	......	w.	....
4:28 p. m.	702.8	10.5	71	wnw.	10.7	965	666.1	7.3	......	w.	....
4:40 p. m.	702.3	10.3	72	wnw.	13.4	526	702.8	10.3	72	wnw.	13.4
Feb 25.											
2:59 p. m.	715.1	— 3.8	88	nw.	14.3	526	715.1	— 3.8	88	nw.	14.3
3:15 p. m.	715.2	— 3.4	81	nw.	14.3	846	686.6	— 7.7	......	nw.	....
3:33 p. m.	715.4	— 3.6	82	nw.	11.2	1,316	646.3	—12.5	......	nw.	....
3:48 p. m.	715.5	— 3.6	88	nw.	10.7	1,639	619.6	—15.3	......	nw.	....
4:00 p. m.	715.6	— 3.5	85	nw.	12.5	1,926	596.9	—16.4	......	nw.	....
4:22 p. m.	715.7	— 3.7	88	nw.	14.3	1,868	601.9	—13.8	......	nw.	....
4:30 p. m.	715.8	— 3.9	88	nw.	13.4	1,885	600.8	—15.7	......	nw.	....
4:50 p. m.	715.9	— 4.2	87	wnw.	14.8	1,843	603.6	—15.4	......	nw.	....
5:40 p. m.	716.2	— 5.3	......	nw.	10.7	526	716.2	— 5.3	......	nw.	10.7
Feb. 26.											
7:16 a. m.	718.0	— 6.3	57	w.	5.4	526	718.0	— 6.3	57	w.	5.4
7:26 a. m.	718.0	— 6.1	57	w.	5.4	846	689.3	— 5.8	......	w.	....
8:21 a. m.	717.9	— 3.7	49	w.	5.4	1,161	662.7	— 1.3	......	w.	....
8:50 a. m.	717.8	— 3.7	42	w.	4.5	2,041	593.0	— 4.9	......	w.	....
9:35 a. m.	717.4	— 1.5	49	sw.	2.2	2,802	537.7	— 9.3	......	w.	....
9:53 a. m.	717.1	— 1.3	46	ese.	1.8	3,518	489.8	—13.4	......	wsw.	....
0:10 a. m.	716.8	— 0.6	53	se.	2.2	3,963	461.7	—12.8	......	wsw.	....
11:03 a. m.	716.2	0.4	49	sse.	3.6	3,798	471.7	—12.4	......	w.	....
11:37 a. m.	716.0	1.1	52	sse.	4.0	3,362	499.7	— 9.9	......	wsw.	....
12:23 p. m.	715.1	2.3	44	se.	6.7	2,628	549.2	— 6.4	......	wsw.	....
12:46 p. m.	715.0	3.2	41	se.	5.8	1,683	619.0	— 2.4	......	wsw.	....
12:55 p. m.	714.7	3.1	38	se.	4.0	1,821	647.4	— 0.6	......	wsw.	....
12:56 p. m.	714.7	3.1	38	se.	4.0	1,280	650.7	— 1.4	......	wsw.	....
12:58 p. m.	714.7	3.3	38	se.	4.0	1,094	666.0	— 1.0	......	wsw.	....
11:07 p. m.	714.6	3.9	44	ssw.	4.0	897	682.6	0.7	......	sw.	....
1:16 p. m.	714.2	2.9	41	s.	5.4	526	714.2	2.9	41	s.	5.4

February 24, 1909.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 4,500 m.; at maximum altitude, 4,000 m.

The sky was covered with nimbus moving from the southwest until 2:21 p. m. and with A.-St. from the southeast until 2:55 p. m. From 1/10 to 8/10 St.-Cu. from the west and from 1/10 to 4/10 A.-St. from the west-southwest were visible thereafter. Light rain fell from 12:15 to 2:21 p. m., from 3:11 to 3:23 p. m., and from 3:55 to 4:05 p. m. Head kite entered clouds at 2:55 and emerged at 3:55 p. m.

Very low pressure was central over Lake Huron and high over New Brunswick.

February 25, 1909.—Three kites were used; lifting surface, 18.0 sq. m. Wire out, 4,500 m.; at the maximum altitude, 3,000 m.

During the flight cumulus clouds were continually forming above the mountain and dissipating after they had passed beyond it, their elevation above station being about 1,300 to 1,400 m. They averaged about 4/10 in amount and were moving from the northwest.

At 8 a. m. a low of considerable intensity, accompanied by general precipitation, was central over the Gulf of St. Lawrence. High pressure, central over Louisiana, covered the Middle and Southern States.

February 26, 1909.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 6,500 m., at maximum altitude.

From 4/10 to 7/10 of the sky was covered with Ci.-St., moving from the west, during the flight. A solar halo at intervals between 8:45 a. m. and noon.

Low pressure was central over Wisconsin and over the Gulf of St. Lawrence. Pressure was high from Maryland to the Gulf of Mexico.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind dir.	Wind vel.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Feb. 27.	Mm.	° C.	%		p. s.	Meters.	Mm.	° C.	%		Meters p. s.
7:30 a. m.	707.7	5.2	41	sw.	5.4	526	707.7	5.2	41	sw.	5.4
7:40 a. m.	707.8	5.6	40	wsw.	6.7	915	674.8	3.8	......	wsw.	....
7:56 a. m.	707.9	4.6	44	wsw.	9.8	1,368	637.6	— 0.5	......	w.	....
8:08 a. m.	707.9	4.2	48	w.	9.8	1,849	600.1	— 4.6	......	w.	....
8:24 a. m.	707.9	3.8	60	w.	8.5	2,116	580.2	— 5.6	......	w.	....
8:47 a. m.	707.9	4.2	59	wnw.	6.7	2,830	529.8	—10.9	......	w.	....
9:16 a. m.	707.8	5.0	62	wnw.	8.5	3,941	457.2	—18.5	......	wnw.	....
9:44 a. m.	707.7	5.8	64	w.	8.5	4,568	421.0	—21.2	......	w.	....
9:57 a. m.	707.6	5.9	64	wnw.	6.3	4,501	430.8	— 4.8	......	wnw.	....
10:54 a. m.	707.4	6.8	64	wnw.	8.5	3,569	485.3	— 8.0	......	wnw.	....
11:33 a. m.	707.2	8.0	59	wnw.	8.9	2,740	538.1	— 2.2	......	wnw.	....
11:56 a. m.	707.1	7.9	56	wnw.	7.2	2,089	583.5	— 0.6	......	wnw.	....
12:11 p. m.	707.1	8.8	59	wnw.	6.8	1,542	624.5	1.4	......	w.	....
12:18 p. m.	707.1	8.9	60	wnw.	6.8	712	691.4	6.6	......	wnw.	....
12:28 p. m.	707.1	8.1	59	w.	5.4	526	707.1	8.1	59	w.	5.4
Mar. 1.											
9:14 a. m.	719.8	— 3.2	72	se.	5.4	526	719.8	— 3.2	72	se.	5.4
9:24 a. m.	719.8	— 3.3	74	se.	5.4	698	704.8	— 4.3	......	s.	......
9:37 a. m.	719.9	— 3.1	75	se.	5.4	787	696.5	— 2.5	......	ssw.	....
9:51 a. m.	720.0	— 2.7	74	se.	5.4	1,135	666.6	— 4.1	......	sw.	....
10:57 a. m.	719.0	— 0.7	62	se.	5.8	2,171	584.4	— 6.5	......	wsw.	....
11:23 a. m.	718.6	0.8	63	sse.	6.3	3,212	510.2	— 11.7	......	w.	....
12:15 p. m.	717.6	1.9	59	s.	6.3	3,854	468.9	—15.2	......	w.	....
1:20 p. m.	717.2	3.2	57	s.	7.2	526	717.2	3.2	57	s.	7.2
Mar. 2.											
7:24 a. m.	710.1	6.3	68	ssw.	4.9	526	710.1	6.3	68	ssw.	4.9
7:41 a. m.	710.1	6.1	68	ssw.	4.9	844	683.1	6.0	61	sw.	....
8:10 a. m.	710.1	5.6	78	s.	4.9	1,054	665.7	4.9	67	wsw.	....
8:28 a. m.	710.1	4.8	79	ssw.	4.9	1,612	621.1	1.2	92	w.	....
11:50 a. m.	709.4	8.5	69	w.	4.6	526	709.4	8.5	69	w.	4.6

February 27, 1909.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 8,500 m.; at maximum altitude, 8,000 m.

The sky was covered with St. moving from the west until 8.21 a. m. The amount decreased to a few at 10:12 a. m., and increased to 3/10 at the close of the flight. From 1/10 to 5/10 A.-St. from the west from 8:30 to 8:57 a. m. Light rain fell from 8:04 to 8:38 a. m. The head kite was in the clouds from 8:13 to 8:27 a. m., and from 9:31 to 10:36 a. m.

Low pressure was central over New York and high over Colorado and Winnipeg.

March 1, 1909.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 6,500 m., at the maximum altitude.

The sky was overcast with Cl.-St. moving from the west-northwest at the beginning of the flight. By the end of the flight the clouds had decreased to 3/10 Cl.-St. A solar halo from the beginning of the flight until 10:55 a. m.

High pressure central over Delaware extended over the Atlantic States. A trough of low pressure extended from Minnesota southwestward, with centers over Minnesota and Oklahoma.

March 2, 1909.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 1,700 m., at maximum altitude.

The sky was covered with St., moving from the west. Light rain fell from 8:28 to 8:34 a. m.

Low pressure was central over Pennsylvania and North Dakota, and high over New Mexico.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.					*Meters*						*Meters*
Mar. 3.	*Mm.*	° *C.*	%		*p. s.*	*Meters.*	*Mm.*	° *C.*	%		*p. s.*
9:09 a. m..	704.7	2.8	100	se.	6.8	526	704.7	2.8	100	se.	6.8
9:22 a. m..	704.5	2.7	100	se.	6.8	727	687.1	0.9	98	se.	....
9:43 a. m..	703.9	2.2	100	se.	8.9	978	665.4	1.8	97	sse.	....
10:18 a. m..	703.4	1.9	100	se.	8.9	1,231	644.7	2.5	67	s.	....
10:44 a. m..	703.0	1.9	100	se.	8.9	1,586	616.4	1.0	46	s.	....
11:01 a. m..	702.8	2.1	100	se.	8.5	1,290	639.4	2.6	67	s.	....
11:14 a. m..	702.7	2.1	100	se.	8.0	977	664.5	2.2	93	sse.	....
11:23 a. m..	702.7	2.1	100	se.	6.3	810	678.4	2.0	96	sse.	....
11:29 a. m..	702.7	2.1	100	se.	5.4	526	702.7	2.1	100	se.	5.4
Mar. 5.											
8:07 a. m..	709.8	— 4.6	60	wnw.	12.1	526	709.8	— 4.6	60	wnw.	12.1
8:20 a. m..	709.4	— 4.1	55	wnw.	16.1	1,081	664.9	—10.3	......	w.	....
9:20 a. m..	710.1	— 3.3	42	wnw.	12.5	1,537	628.4	—13.5	......	wnw.	....
10:10 a. m..	710.5	— 2.7	53	wnw.	13.4	1,570	621.2	—13.6	......	wnw.	....
10:35 a. m..	710.7	— 2.7	51	wnw.	13.4	1,153	655.9	— 9.6	......	wnw.	....
10:48 a. m..	710.8	— 2.5	59	wnw.	13.0	944	674.1	— 6.9	......	wnw.	....
10:54 a. m..	711.0	— 1.9	49	wnw.	13.4	526	711.0	— 1.9	49	wnw.	13.4
2d flight:											
1:27 p. m..	710.7	0.1	45	wnw.	14.3	526	710.7	0.1	45	wnw.	14.3
1:39 p. m..	710.7	0.8	37	wnw.	10.7	901	678.1	— 3.4	49	wnw.	....
2:19 p. m..	710.9	1.1	41	wnw.	11.2	1,381	638.1	— 7.4	54	wnw.	....
2:57 p. m..	711.2	1.6	53	wnw.	12.5	1,766	607.9	— 9.1	......	wnw.	....
3:17 p. m..	711.3	1.7	53	wnw.	12.5	2,278	569.7	— 9.9	......	wnw.	....
3:58 p. m..	711.5	1.7	37	wnw.	10.3	2,702	539.4	—12.4	......	wnw.	....
4:19 p. m..	711.7	1.8	52	wnw.	9.8	2,439	558.1	—11.5	......	wnw.	....
4:38 p. m..	711.8	1.8	62	wnw.	10.3	1,797	606.1	— 9.1	28	wnw.	....
4:54 p. m..	711.9	1.7	64	wnw.	8.9	1,364	640.7	— 6.2	54	w.	....
5:04 p. m..	712.0	1.7	52	wnw.	8.5	968	673.7	— 3.1	52	w.	....
5:15 p. m..	712.1	1.5	46	wnw.	9.4	526	712.1	1.5	46	wnw.	9.4

March 3, 1909.—Three kites were used; lifting surface, 14.5 sq. m. Wire out, 3,200 m., at the maximum altitude.

Light rain and dense fog prevailed during the flight.

Low pressure was central over Lake Erie, and high pressure was central over Nebraska.

March 5, 1909.—One kite was used; lifting surface, 6.3 sq. m. Wire out, 3,000 m.; at maximum altitude, 2,000 m.

About 1/10 St.-Cu. moving from the northwest.

Second flight: Four kites were used; lifting surface, 18,2 sq. m. Wire out, 6,000 m.; at maximum altitude, 5,400 m.

A few St.-Cu. moving from the northwest until 4:47 p. m. The sky was cloudless thereafter.

A high was central over Florida and a low over the Gulf of St. Lawrence.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Mar. 6.	*Mm.*	° C.	%		*Meters p. s.*	*Meters.*	*Mm.*	° C.	%		*Meters p. s.*
7:25 a. m.	713.8	— 1.1	57	se.	6.7	526	713.8	— 1.1	57	se.	6.7
7:37 a. m.	713.8	— 1.1	54	se.	6.7	892	681.9	— 0.8	41	sse.	....
8:00 a. m.	713.8	— 1.0	57	se.	6.8	1,074	666.6	1.0	40	s.	....
8:30 a. m.	713.8	— 1.1	63	se.	8.0	1,464	634.9	— 1.6	50	sw.	....
8:49 a. m.	713.8	— 1.1	66	se.	7.2	2,401	564.0	— 5.9	100	sw.	....
9:20 a. m.	713.6	— 0.8	62	se.	7.2	2,560	....	— 6.5	71	sw.	....
9:30 a. m.	713.5	— 0.7	63	se.	8.0	2,974	523.9	— 8.1	85	sw.	....
9:57 a. m.	713.5	— 0.8	68	ese.	6.7	3,234	506.5	— 9.8	89	sw.	....
10:16 a. m.	713.4	— 0.9	63	ese.	9.4	2,990	....	— 8.4	97	sw.	....
10:29 a. m.	713.4	— 1.1	68	ese.	7.2	2,709	541.8	— 6.8	94	sw.	....
10:49 a. m.	712.8	— 1.1	68	e.	7.6	2,186	578.6	— 4.6	95	sw.	....
11:10 a. m.	712.4	— 1.8	70	e.	9.4	1,776	609.8	— 4.0	100	sw.	....
11:26 a. m.	712.3	— 1.6	72	e.	9.8	1,252	650.3	— 0.6	84	s.	....
11:39 a. m.	712.3	— 1.7	78	e.	8.5	874	681.9	— 1.3	71	sse.	....
11:45 a. m.	712.1	— 1.7	78	e.	7.7	670	....	— 2.0	53	sse.	....
11:49 a. m.	712.0	— 1.7	78	ese.	8.9	526	712.9	— 1.7	78	sse.	8.9
Mar. 8.											
2:46 p. m.	717.4	4.7	59	ese.	4.9	526	717.4	4.7	59	ese.	4.9
2:58 p. m.	717.3	4.4	61	ese.	5.8	717	700.7	2.2	62	se.	....
3:15 p. m.	717.2	4.4	61	ese.	6.7	1,408	643.5	0.3	60	sw.	....
3:28 p. m.	717.1	4.4	61	ese.	6.7	1,892	605.3	1.3	48	wsw.	....
3:50 p. m.	716.9	4.4	61	ese.	7.6	2,840	572.4	0.1	49	wsw.	....
4:11 p. m.	716.9	4.3	62	ese.	7.2	3,254	510.1	— 3.7	90	wsw.	....
5:00 p. m.	717.2	3.2	60	e.	8.9	2,711	546.6	0.3	90	wsw.	....
5:28 p. m.	717.4	2.7	64	e.	7.2	1,973	599.1	1.0	58	wsw.	....
5:42 p. m.	717.5	2.7	60	e.	6.7	1,423	641.7	— 1.0	82	sw.	....
5:52 p. m.	717.6	2.5	61	e.	5.8	709	701.6	2.8	70	se.	....
5:57 p. m.	717.7	2.5	61	e.	5.8	526	717.7	2.5	61	e.	5.8
Mar. 9.											
8:33 a. m.	716.1	0.0	100	se.	8.0	526	716.1	0.0	100	se.	8.0
8:49 a. m.	715.8	0.1	100	se.	8.0	854	687.4	5.2	99	s.	....
9:02 a. m.	715.8	0.3	100	se.	7.2	1,825	649.2	9.7	90	sw.	....
9:19 a. m.	715.6	0.6	100	se.	6.7	1,647	624.4	9.1	86	sw.	....
9:28 a. m.	715.6	0.6	100	se.	7.2	1,984	599.5	7.5	61	sw.	....
9:59 a. m.	715.6	0.9	100	se.	7.6	2,195	584.4	6.9	45	sw.	....
10:30 a. m.	714.8	1.3	100	se.	6.7	1,631	626.2	11.9	37	sw.	....
10:55 a. m.	714.7	1.6	100	se.	7.2	1,326	649.2	13.2	42	sw.	....
11:14 a. m.	714.6	1.8	100	se.	7.2	930	680.4	12.5	83	sw.	....
11:28 a. m.	714.5	2.1	100	se.	6.7	526	714.5	2.1	100	se.	6.7

March 6, 1909.—Four kites were used; lifting surface, 25.2 sq, m. Wire out, 6,000 m.; at maximum altitude, 5,520 m.

The sky was overcast; until 9 a. m. with St. moving from the west-southwest; from 9 to 10 a. m. with A.-St. moving from the west, and with St.; after 10 a. m. with St. and Nb. Snow fell after 10:39 a. m.. The head kite entered the cloud base at 8:49 a. m., altitude 2,400 m.; and in descending emerged about 11:20 a. m., altitude about 1,425 m. The wire was slightly coated with frost for 3,000 m. from the head kite.

A trough of low pressure covered the Mississippi Valley. Pressure was relatively high off the New Jersey coast.

March 8, 1909.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 4,200 m., at maximum altitude.

At the beginning the sky was overcast with A.-St. moving from the west. A little later St. moving from the west-southwest appeared and by 3:28 p. m. half covered the sky.

Pressure was high north of the Lakes and low over southern Texas.

March 9, 1909.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 4,500 m.; at maximum altitude, 4,300 m.

Dense fog prevailed.

A low was central over Missouri. Pressure was high over the north Atlantic coast.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m. Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	At different heights above sea. Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Mar. 10.	*Mm.*	° *C.*	%		*Meters p. s.*	*Meters.*	*Mm.*	° *C.*	%		*Meters p. s.*
7:20 a. m.	705.9	13.1	83	sw.	7.6	526	705.9	13.1	83	sw.	7.6
7:48 a. m.	705.9	12.8	86	sw.	5.8	887	675.8	11.8	......	sw.	....
8:09 a. m.	705.9	12.7	86	sw.	5.8	1,528	625.8	6.4	......	sw.	....
8:38 a. m.	706.0	13.1	84	sw.	4.9	1,181	652.5	9.8	......	sw.	....
8:55 a. m.	706.1	13.0	86	sw.	3.1	526	706.1	13.0	86	sw.	3.1
2d flight.											
9:52 a. m.	706.0	16.4	66	sw.	8.9	526	706.0	16.4	66	sw.	8.9
10:04 a. m.	706.0	16.7	60	sw.	10.8	845	679.9	12.4	......	sw.	....
10:18 a. m.	706.0	16.8	58	sw.	13.9	1,172	653.5	9.5	......	sw.	....
10:26 a. m.	705.9	17.2	56	sw.	13.4	1,549	625.0	7.1	......	sw.	....
10:37 a. m.	705.9	17.5	54	sw.	11.2	1,996	592.1	4.8	......	sw.	....
10:50 a. m.	705.8	17.6	48	sw.	12.1	2,346	567.2	1.8	......	sw.	....
11:00 a. m.	705.8	17.9	47	sw.	12.1	526	705.8	17.9	47	sw.	12.1
Mar. 11.											
1:54 p. m.	720.6	5.1	33	nw.	18.9	526	720.6	5.1	33	nw.	18.9
1:59 p. m.	720.6	5.0	34	nw.	15.6	768	697.7	1.6	32	nw.	....
2:33 p. m.	720.5	5.6	34	nw.	17.0	1,303	654.4	−0.9	35	nw.	....
2:57 p. m.	720.5	5.7	34	nw.	16.1	719	703.6	1.6	36	nw.	....
5:20 p. m.	721.7	5.8	37	nw.	8.9	526	721.7	5.8	37	nw.	8.9
Mar. 12.											
11:10 a. m.	724.2	2.8	47	sse.	4.9	526	724.2	2.8	47	sse.	4.9
11:54 a. m.	723.9	3.8	41	se.	7.2	51	....	−1.4	......	se.	....
12:26 p. m.	723.7	5.0	41	se.	6.8	96	....	−1.7	......	ssw.	....
12:35 p. m.	723.3	5.2	41	se.	5.8	21	....	2.1	......	wsw.	....
1:02 p. m.	722.5	5.8	38	se.	5.8	28	....	1.9	......	wsw.	....
1:14 p. m.	722.4	6.4	39	se.	7.6	66	....	−2.2	......	wsw.	....
1:25 p. m.	722.2	5.8	41	se.	6.3	53	....	−4.4	......	wsw.	....
1:47 p. m.	721.8	6.0	48	sse.	6.7	37	....	−6.4	......	wsw.	....
2:17 p. m.	721.6	7.2	43	se.	6.7	88	456.0	−9.5	65	w.	....
3:04 p. m.	721.0	8.2	42	se.	6.7	90	480.3	−5.9	55	w.	....
3:32 p. m.	721.0	7.7	43	sse.	7.2	61	507.3	−4.0	69	wsw.	....
3:35 p. m.	721.0	7.7	43	sse.	6.8	86	....	−3.6	76	wsw.	....
4:10 p. m.	720.9	7.8	41	sse.	4.9	14	....	0.5	79	wsw.	....
4:19 p. m.	720.9	7.8	49	sse.	6.7	90	537.4	1.6	51	wsw.	....
4:24 p. m.	720.8	7.2	44	s.	7.2	69	608.3	3.6	33	sw.	....
4:33 p. m.	720.8	6.6	45	sse.	5.4	60	619.1	2.1	40	sw.	....
4:40 p. m.	720.7	6.8	46	s.	7.2	1,422	645.4	0.8	47	sw.	....
4:54 p. m.	720.7	6.1	44	s.	6.8	871	690.9	4.0	53	s.	....
5:00 p. m.	720.5	6.1	45	sse.	6.3	526	720.5	6.1	45	sse.	6.3

March 10, 1909.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 2,000 m.; at maximum altitude, 1,800 m.

About 7/10 St.-Cu. moving from the west-southwest.

Second flight: Three kites were used, lifting surface, 14.5 sq. m. Wire out, 3,700 m., at maximum altitude.

About 4/10 A.-St. moving from the southwest and 2/10 St. from the west.

Low pressure was central over New York and Michigan and high over Alberta.

March 11, 1909.—Three kites were used; lifting surface, 12.8 sq. m. Wire out, 3,000 m.; at maximum altitude, 2,800 m.

From 3/10 to 5/10 Ci.-St. moving from the northwest during the flight.

At 8 a. m. an extensive high was central over North Dakota and a low, accompanied by general precipitation, was moving off the New England coast.

March 12, 1909.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 8,000 m., at maximum altitude.

Clouds of the cirrus level moving from the west varied from 1/10 to 4/10 until 4:15 p. m.; A.-Cu. then appeared, moving from the west, and covered the sky by 5 p. m.

High pressure was central over eastern Maryland. Pressure was relatively low over the Gulf of St. Lawrence.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
1909.											
Mar. 13.	*Mm.*	° *C.*	%		*p. s.*	*Meters.*	*Mm.*	° *C.*	%		*p. s.*
8:50 a. m.	715.0	5.7	98	wsw.	3.6	526	715.0	5.7	96	wsw	3.6
10:13 a. m.	715.0	6.1	100	w.	1.8	801	691.5	5.2	58	w.	....
10:26 a. m.	715.0	6.7	100	w.	2.7	526	715.0	6.7	100	w.	2.7
Mar. 15.											
7:24 a. m.	715.8	− 3.1	70	nw.	7.6	526	715.8	− 3.1	70	nw.	7.6
7:30 a. m.	715.9	− 2.9	68	nw.	7.6	816	690.0	− 6.1	72	nw.	....
7:50 a. m.	716.2	− 2.8	67	nw.	11.6	1,170	659.7	− 3.6	77	nnw.	....
8:16 a. m.	716.4	− 2.4	64	nw.	11.6	1,589	601.2	−12.7	70	nw.	....
9:25 a. m.	716.4	− 0.6	53	nw.	12.1	1,516	631.5	−10.6	......	nw.	....
9:28 a. m.	716.4	− 0.7	51	nw.	12.1	1,304	608.8	− 8.5	......	nw.	....
9:41 a. m.	716.5	− 0.3	60	nw.	13.4	2,678	548.4	−11.4	.....	nw.	....
10:27 a. m.	716.5	− 0.4	55	wnw.	14.3	3,875	464.2	....	......	nw.	....
11:35 a. m.	716.6	− 0.4	68	wnw.	13.4	1,786	610.1	−11.5	......	nw.	....
12:10 p. m.	716.6	− 0.8	58	wnw.	12.8	1,278	651.8	− 8.4	......	nw.	....
12:24 p. m.	716.6	− 1.1	62	wnw.	12.1	879	685.6	− 4.4	.....	nw.	....
12:31 p. m.	716.6	− 1.1	68	wnw.	12.1	526	716.6	1.1	48	wnw.	12.1
Mar. 16.											
7:34 a. m.	717.0	− 1.4	52	s.	4.5	526	717.0	− 1.4	52	s.	4.5
7:43 a. m.	717.0	− 1.3	50	s.	6.3	895	684.7	− 3.9	57	s.	....
7:58 a. m.	717.0	− 1.0	62	s.	7.2	1,386	642.9	− 7.0	68	sw.	....
8:20 a. m.	716.8	− 1.1	49	s.	6.7	1,828	607.4	− 9.0	63	sw.	....
8:40 a. m.	716.7	− 1.7	61	s.	4.9	2,369	566.4	−10.7	33	wsw.	....
8:58 a. m.	716.5	− 1.8	57	s.	6.7	2,679	529.9	−13.1	22	wsw.	....
9:10 a. m.	716.5	− 1.1	64	s.	6.7	3,217	505.8	−15.4	27	w.	....
9:44 a. m.	716.4	− 0.8	55	s.	6.0	3,962	458.7	−17.8	90	w.	....
10:17 a. m.	716.2	0.1	48	s.	6.9	3,559	485.4	−14.7	100	w.	....
10:30 a. m.	716.0	1.1	47	s.	7.2	3,549	486.3	−14.6	94	w.	....
10:50 a. m.	715.9	1.1	53	s.	6.0	3,430	495.2	−13.8	100	wsw.	....
10:58 a. m.	715.8	1.4	46	s.	6.0	3,193	509.5	−12.9	96	wsw.	....
11:27 a. m.	715.4	2.6	49	s.	7.2	2,757	533.8	−12.4	......	wsw.	....
12:01 p. m.	715.0	3.3	51	s.	6.7	1,863	608.8	−10.4	......	sw.	....
12:16 p. m.	714.6	2.2	48	s.	5.4	1,164	659.7	− 4.6	......	ssw.	....
12:30 p. m.	714.2	2.4	50	s.	5.4	804	688.9	− 1.5	......	ssw.	....
12:40 p. m.	714.0	2.2	50	s.	4.9	526	714.0	2.2	50	s.	4.9

March 13, 1909.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 1,450 m.; at maximum altitude, 1,100 m.

The sky was obscured by St. moving from the west, except from 10:15 to 10:20 a. m., when dense fog prevailed. Light rain fell throughout the flight. The head kite was obscured at intervals from 9:05 to 10:20 a. m.

A trough of moderately low pressure extended from Texas to Pennsylvania. Slightly higher pressure prevailed over Florida and Ontario.

March 15, 1909.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 6,300 m., at maximum altitude.

About 2/10 St.-Cu. moving from the northwest at the beginning of the flight. The clouds increased to 8/10 by the end of the flight. The base of the clouds was about 1,550 m. above sea level. The head kite was in the clouds from 9:25 until 11:43 a. m. Snow flurries occurred from 10:20 to 10:35 a. m. and from 12:07 to 12:19 p. m.

High pressure was central over Missouri and pressure was low over New Brunswick, with a secondary depression over Florida.

March 16, 1909.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 7,000 m., at maximum altitude.

From 2/10 to 8/10 Ci.-St. moving from the west until 8:44 a. m.; 5/10 to 10/10 A.-St. from the west from 8 to 10:45 a. m. and 1/10 to 8/10 St. from the west-southwest thereafter. The head kite entered the clouds at 9.40 a. m. and reappeared at 11:17 a. m.

A high was central over North Carolina and a low over northern Michigan.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Mar. 17.	*Mm.*	° *C.*	%		*Meters p. s.*	*Meters.*	*Mm.*	° *C.*	%		*Meters p. s.*
1:47 p. m.	714.2	— 0.6	29	wnw.	11.2	526	714.2	— 0.6	29	wnw.	11.2
1:55 p. m.	714.1	— 1.1	27	wnw.	11.6	866	684.1	— 5.1	22	nw.	....
2:08 p. m.	714.1	— 0.8	28	nw.	13.4	1,120	662.3	— 7.4	27	nw.	....
2:34 p. m.	714.1	— 0.3	34	nw.	11.6	1,518	629.1	—10.7	36	wnw.	....
2:51 p. m.	714.0	0.0	22	nw.	10.7	2,065	586.3	—13.6	......	wnw.	....
3:02 p. m.	714.0	0.0	22	nw.	10.3	2,347	565.0	—11.1	......	nw.	....
3:26 p. m.	714.0	0.0	24	nw.	13.4	2,940	523.1	—14.4	......	nw.	....
3:45 p. m.	714.0	0.2	23	nw.	10.7	3,472	486.7	—16.8	......	nw.	....
4:05 p. m.	714.0	0.0	26	nw.	10.7	2,868	527.6	—13.7	......	nw.	....
4:42 p. m.	714.1	— 0.5	34	nw.	11.2	2,300	568.5	—10.2	......	nw.	....
4:55 p. m.	714.2	— 0.4	27	wnw.	12.1	1,951	595.2	—12.6	31	wnw.	....
5:07 p. m.	714.2	— 0.8	43	nw.	14.3	1,611	621.9	—10.9	43	wnw.	....
5:18 p. m.	714.3	— 1.0	35	nw.	12.5	1,171	658.2	— 7.2	41	nw.	....
5:28 p. m.	714.3	— 1.1	27	nw.	13.4	879	683.2	— 4.9	33	nw.	....
5:33 p. m.	714.4	— 1.2	28	nw.	13.4	526	714.4	— 1.2	28	nw.	13.4
Mar. 18.											
7:16 a. m.	718.2	— 6.6	70	wnw.	9.8	526	718.2	— 6.6	70	wnw.	9.8
7:30 a. m.	718.2	— 6.1	64	wnw.	10.7	951	680.0	—10.0	70	nw.	....
7:50 a. m.	718.4	— 5.9	65	wnw.	9.8	1,357	645.8	—10.1	52	nw.	....
8:04 a. m.	718.5	— 5.6	64	wnw.	10.3	1,768	612.6	— 6.6	51	nw.	....
8:19 a. m.	718.5	— 4.9	58	wnw.	10.7	2,076	588.5	— 8.2	44	nnw.	....
9:23 a. m.	718.6	— 3.2	51	wnw.	10.3	2,330	584.2	— 9.6	31	nnw.	....
9:43 a. m.	718.7	— 2.5	48	wnw.	11.2	3,640	480.8	—18.1	27	nw.	....
10:27 a. m.	718.7	— 2.0	46	wnw.	8.0	4,231	444.4	—16.8	......	nw.	....
11:27 a. m.	718.8	— 0.4	40	wnw.	7.2	3,659	480.8	—18.4	......	nw.	....
1:07 p. m.	718.2	1.7	46	wnw.	7.6	1,630	624.2	— 5.2	......	nw.	....
1:16 p. m.	718.1	1.9	38	wnw.	8.0	1,448	639.2	— 3.0	41	wnw.	....
1:22 p. m.	718.0	2.2	39	wnw.	8.0	871	687.8	— 2.6	......	wnw.	....
1:34 p. m.	717.8	3.1	42	wnw.	8.0	526	717.8	3.1	42	wnw.	8.0
Mar. 19.											
7:24 a. m.	713.6	2.2	48	sse.	6.3	526	713.6	2.2	48	sse.	6.3
7:32 a. m.	713.6	2.2	48	s.	5.4	896	681.8	4.1	61	ssw.	....
8:10 a. m.	713.1	2.8	44	s.	5.8	1,792	609.9	— 1.5	90	sw.	....
8:24 a. m.	713.0	2.7	45	s.	6.3	2,307	571.6	— 2.6	95	wsw.	....
8:43 a. m.	712.8	2.3	58	s.	6.7	2,426	562.7	— 4.0	100	wsw.	....
9:05 a. m.	712.7	2.2	58	s.	5.4	2,477	559.1	— 4.0	88	wsw.	....
10:15 a. m.	712.4	1.7	77	s.	7.2	2,447	560.9	— 4.2	88	w.	....
10:40 a. m.	712.3	1.4	78	s.	7.2	2,077	587.6	— 2.6	90	wsw.	....
10:45 a. m.	712.3	1.4	78	s.	5.4	526	712.3	1.4	78	s.	5.4

March 17, 1909.—Three kits were used; lifting surface, 18.9 sq. m. Wire out, 7,000 m., at maximum altitude.

A few St.-Cu. moving from the northwest at the beginning, but disappeared by 3:06 p. m. The sky was cloudless during the remainder of the flight.

High pressure was central over Iowa and low pressure over the upper St. Lawrence.

March 18, 1909.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 8,650 m., at maximum altitude.

A few Ci.-St. moving from the northwest near the southwestern horizon. At an altitude of about 1,500 m. there were frequent formations of cumulus clouds, which, however, soon dissipated. While they lasted, they moved from the west-northwest. Dense haze prevailed throughout the day.

At 8 a. m. high pressure covered the Middle Atlantic States and a low was central over eastern Kansas.

March 19, 1909.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 8,000 m.; at maximum altitude, 7,000 m.

The sky was obscured by St. moving from the west-southwest. Light rain began at 8.24 a. m. and continued until the close of the flight. The head kite entered the clouds at the same time.

High pressure was central over the south Atlantic coast and low pressure over Ohio.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.					Meters.						Meters.
Mar. 20.	Mm.	° C.	%		p. s.	Meters.	Mm.	° C.	%		p. s.
7:24 a. m.	709.9	5.2	67	nw.	13.0	526	709.9	5.2	67	nw.	13.0
7:33 a. m.	710.0	5.4	66	nw.	14.3	892	678.7	1.4	75	wnw.	....
7:44 a. m.	710.0	5.3	67	wnw.	16.1	1,238	650.0	— 1.1	......	wnw.	....
7:49 a. m.	709.9	5.3	68	wnw.	14.3	1,335	642.2	5.0	......	wnw.	....
7:56 a. m.	709.9	5.3	63	wnw.	14.8	1,686	618.9	3.5	......	wnw.	....
8:20 a. m.	711.0	5.6	62	wnw.	11.2	2,842	568.0	0.5	......	wnw.	....
9:01 a. m.	711.2	5.9	63	wnw.	10.7	3,261	506.2	— 4.9	......	wnw.	....
9:23 a. m.	711.2	5.8	62	nw.	10.7	3,716	477.5	— 7.8	......	wnw.	....
10:31 a. m.	711.4	5.7	60	nw.	10.7	2,656	546.4	— 0.7	......	wnw.	....
10:56 a. m.	711.4	6.3	61	nw.	9.8	1,819	606.3	2.7	......	wnw.	....
11:08 a. m.	711.4	6.1	58	nw.	10.3	1,415	637.3	4.3	......	nw.	....
11:31 a. m.	711.5	6.1	57	nw.	11.2	1,166	657.2	— 1.1	......	nw.	....
11:41 a. m.	711.5	6.1	56	nw.	11.2	839	684.6	1.7	......	nw.	....
11:50 a. m.	711.2	6.6	54	nw.	11.2	526	711.2	6.6	54	nw.	11.2
Mar. 22.											
7:34 a. m.	716.8	— 6.6	70	nw.	8.9	526	716.8	— 6.6	70	nw.	8.9
7:42 a. m.	716.9	— 6.5	69	nw.	10.8	884	684.8	— 7.9	53	nnw.	....
8:05 a. m.	717.0	— 6.1	70	nw.	9.8	1,303	649.2	— 8.9	17	nnw.	....
8:33 a. m.	717.2	— 5.3	60	nw.	10.3	1,691	618.2	— 6.2	8	nnw.	....
9:18 a. m.	717.4	— 3.9	51	nw.	8.9	2,170	581.7	— 8.2	......	nw.	....
9:21 a. m.	717.4	— 3.9	51	nw.	8.9	2,588	555.0	— 7.1	......	nw.	....
10:50 a. m.	717.4	— 1.6	44	nw.	9.8	3,856	469.8	—13.1	......	nw.	....
11:18 a. m.	717.2	— 0.7	40	nw.	9.8	2,129	584.4	— 9.6	......	nw.	....
11:51 a. m.	716.9	— 0.3	37	nw.	9.8	1,666	620.0	— 6.9	......	nw.	....
11:58 a. m.	716.8	— 0.1	34	nw.	9.8	1,437	638.6	— 9.0	10	nw.	....
12:18 p. m.	716.6	0.8	36	nw.	9.8	838	689.1	— 4.0	32	nw.	....
12:28 p. m.	716.5	1.1	27	nw.	10.7	526	716.5	1.1	27	nw.	10.7
Mar. 23.											
7:21 a. m.	719.2	— 5.7	69	nw.	8.5	526	719.2	— 5.7	69	nw.	8.5
7:42 a. m.	719.3	— 5.6	66	wnw.	9.8	917	684.5	— 4.0	41	nw.	....
8:40 a. m.	719.4	— 3.9	59	wnw.	11.2	989	682.8	— 1.3	20	nw.	....
9:08 a. m.	719.4	— 3.2	58	nw.	11.2	1,376	646.3	— 3.3	22	nnw.	....
9:23 a. m.	719.4	— 2.9	55	wnw.	11.2	1,719	618.9	— 5.6	25	nnw.	....
9:37 a. m.	719.4	— 2.3	54	wnw.	10.3	2,546	556.6	— 9.7	27	nnw.	....
10:01 a. m.	719.4	— 1.7	51	wnw.	8.0	3,588	488.9	—12.8	24	nnw.	....
10:50 a. m.	719.0	— 0.3	46	wnw.	7.2	3,779	473.8	—13.9	13	nnw.	....
11:59 a. m.	718.8	1.4	40	nw.	8.5	2,745	542.3	— 9.5	14	nnw.	....
12:30 p. m.	718.6	2.7	38	nw.	10.3	1,861	607.3	— 5.0	18	nnw.	....
12:44 p. m.	718.5	2.8	37	nw.	11.6	1,140	665.4	— 4.0	31	nw.	....
1:02 p. m.	718.4	3.8	36	nw.	8.0	824	692.3	— 0.7	44	nw.	....
1:11 p. m.	718.3	3.2	33	nw.	7.6	526	718.3	3.2	33	nw.	7.6

March 20, 1909.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 6,000 m., at maximum altitude.

At the beginning 3/10 St.-Cu. From 3:15 until 11 a. m. the sky was almost covered with Ci.-St. and St.-Cu. About 3/10 Ci.-St. at end of the flight. The clouds moved from the west-northwest, except that the St.-Cu. moved from the northwest after 10:30 a. m. A solar halo from 8:30 until 10 a. m.

High pressure was central over Lake Superior. Centers of low pressure lay over Rhode Island and Arkansas.

March 22, 1909.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 8,000 m.; at maximum altitude, 7,500 m.

From 2/10 to 4/10 Ci.-St. moving from the northwest during the flight. A few Cu. began to form at 11:36 a. m. Solar halo from the beginning until 8:35 a. m. and from 11:55 a. m. until the end of the flight.

High pressure was central over the upper Lakes and pressure was relatively low off the Atlantic coast.

March 23, 1909.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 7,000 m.; at maximum altitude, 6,360 m.

The sky was cloudless.

High pressure, central over the Lake region, covered the eastern United States.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Mar. 24.	Mm.	° C.	%		Meters p. s.	Meters.	Mm.	° C.	%		Meters p. s.
7:15 a. m.	715.4	2.7	43	sse.	4.0	526	715.4	2.7	43	sse.	4.0
7:43 a. m.	715.1	2.9	47	sse.	5.4	944	679.2	3.6	24	sw.	....
8:00 a. m.	715.0	3.1	44	sse.	5.4	1,410	641.0	0.5	22	sw.	....
8:24 a. m.	714.8	3.9	40	sse.	5.4	1,975	597.5	— 0.2	82	wsw.	....
9:11 a. m.	714.4	3.9	44	sse.	4.9	2,625	550.4	— 1.6	43	w.	....
9:30 a. m.	714.1	4.4	46	sse.	6.7	3,434	497.0	— 5.5	34	w.	....
9:45 a. m.	713.9	4.8	42	sse.	6.8	4,095	456.9	— 9.1	82	wnw.	....
10:00 a. m.	713.7	6.1	37	sse.	5.4	4,501	432.9	—11.9	49	wnw.	....
10:27 a. m.	713.4	6.6	36	sse.	7.2	5,063	402.8	—14.3	43	wnw.	....
10:59 a. m.	713.0	7.8	36	sse.	7.6	4,818	415.4	—12.8	50	wnw.	....
11:49 a. m.	712.2	8.8	36	sse.	7.2	4,206	449.8	— 9.6	70	w.	....
12:22 p. m.	711.7	8.6	38	sse.	6.7	3,711	479.2	— 6.3	85	w.	....
12:53 p. m.	711.2	7.8	40	s.	6.7	2,800	537.0	— 2.5	100	w.	....
1:23 p. m.	710.9	7.2	44	s.	6.8	2,099	586.0	0.9	94	w.	....
1:38 p. m.	710.6	5.6	58	s.	6.3	1,781	609.1	1.7	90	wsw.	....
1:58 p. m.	710.4	4.4	72	s.	6.3	935	675.7	5.5	90	sw.	....
2:06 p. m.	710.4	4.6	69	s.	5.4	526	710.4	4.6	69	w.	5.4
Mar. 26.											
4:21 p. m.	705.5	7.7	29	w.	11.6	526	705.5	7.7	29	w.	11.6
4:25 p. m.	705.5	7.7	29	w.	9.8	769	684.9	4.4	28	wnw.	....
4:40 p. m.	705.6	7.7	29	w.	8.0	1,053	661.4	1.7	33	w.	....
5:04 p. m.	705.7	7.6	30	wnw.	7.6	1,386	634.7	— 1.2	43	w.	....
5:29 p. m.	705.8	7.1	31	wnw.	7.2	2,306	565.4	— 6.3	80	wnw.	....
5:50 p. m.	706.1	7.1	33	wnw.	5.4	526	706.1	7.1	33	wnw.	5.4
Mar. 27.											
1:42 p. m.	703.6	14.4	49	sse.	4.9	526	703.6	14.4	40	sse.	4.9
1:50 p. m.	703.5	15.8	37	sse.	6.7	872	675.2	12.2	40	ssw.	....
2:22 p. m.	703.3	15.6	38	s.	7.2	1,796	603.8	4.2	56	w.	....
2:45 p. m.	703.2	16.8	37	sw.	6.3	2,384	561.5	— 1.4	76	w.	....
3:04 p. m.	703.2	16.4	25	wnw.	8.9	2,855	529.2	— 5.2	78	w.	....
3:30 p. m.	703.2	15.8	28	wnw.	5.8	3,385	494.7	— 3.5	92	wsw.	....
4:00 p. m.	703.1	15.6	31	nw.	5.8	3,160	508.5	— 8.5	88	wsw.	....
4:26 p. m.	703.2	15.2	29	wnw.	6.7	2,404	559.6	— 1.9	76	w.	....
4:37 p. m.	703.2	15.2	30	wnw.	7.6	1,989	589.3	1.6	60	wnw.	....
4:50 p. m.	703.3	14.6	30	wnw.	7.2	1,717	609.6	5.2	46	wnw.	....
5:00 p. m.	703.3	14.4	32	nw.	6.3	1,367	635.8	6.6	44	wnw.	....
5:21 p. m.	703.4	13.3	40	nnw.	6.8	526	703.4	13.3	40	nnw.	6.3

March 24, 1909.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 8,000 m.; at maximum altitude, 7,800 m.

From 1/10 to 5/10 Ci. moving from the west-northwest until 10 a. m. and from 3/10 to 8/10 A.-Cu. from 10 a. m. until 12:18 p. m. The sky was obscured by St.-Cu. from the west from 12:18 to 12:50 p. m., and by St. from the west-southwest thereafter. Light rain fell after 1:15 p. m. The head kite was in the clouds from 10:13 to 11:49 a. m. and at frequent intervals thereafter until 12:53 p. m., when it emerged from the clouds at an altitude of 2,800 m.

High pressure was central over the Virginia and Carolina coasts and low pressure over Lake Superior.

March 26, 1909.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 2,740 meters.; at maximum altitude, 2,700 meters.

A few St.-Cu. moving from the west-northwest until 5 p. m.

Very low pressure was central over the St. Lawrence Valley. Pressure was relatively high over the Gulf States.

March 27, 1909.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 7,000 m.; at maximum altitude, 6,200 m.

From 7/10 to 10/10 St.-Cu. from the west until 3 p. m., and 10/10 St.-Cu. from the west-southwest thereafter. Light rain fell after 5:08 p. m. The head kite was obscured by clouds at intervals from 2:40 to 4:09 p. m.

High pressure was central over Florida and low pressure over Texas and Lake Superior.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air tem.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909. Mar. 29.	Mm.	° C.	%		Meters p. s.	Meters.	Mm.	° C.	%		Meters p. s.
7:16 a. m.	708.5	0.6	66	wnw.	8.0	526	708.5	0.6	66	wnw.	8.0
7:25 a. m.	708.5	1.2	60	wnw.	8.5	882	677.7	— 1.0	60	wnw.	....
7:35 a. m.	708.6	1.7	57	wnw.	6.7	1,275	645.0	— 4.3	56	wnw.	....
7:48 a. m.	708.6	2.7	49	wnw.	7.2	1,775	605.3	— 8.2	52	wnw.	....
8:00 a. m.	708.7	3.8	45	wnw.	6.7	2,217	571.9	—11.9	62	wnw.	....
8:10 a. m.	708.7	3.3	45	wnw.	7.6	2,468	553.2	—10.9	44	wnw.	....
8:57 a. m.	708.7	3.9	43	w.	8.0	3,311	496.2	—18.7	23	wnw.	....
11:18 a. m.	708.4	7.0	38	wnw.	8.5	2,815	540.7	—12.8	......	wnw.	....
11:50 a. m.	708.4	6.8	31	wnw.	9.4	1,774	606.2	— 6.7	.....	wnw.	....
12:14 p. m.	708.3	8.2	82	w.	10.7	1,286	645.0	— 1.5	......	w.	....
12:29 p. m.	708.2	8.8	31	wnw.	10.3	876	678.7	4.2	39	w.	....
12:36 p. m.	708.1	7.7	32	wnw.	10.3	526	708.1	7.7	32	wnw.	10.3
Mar. 30.											
8:46 a. m.	707.6	— 0.9	83	wnw.	8.0	526	707.6	— 0.9	83	wnw.	8.0
8:55 a. m.	707.6	— 0.6	79	wnw.	9.8	905	674.7	— 3.9	84	wnw.	....
9:10 a. m.	707.6	— 0.4	76	wnw.	10.3	1,294	642.0	— 7.2	94	wnw.	....
9:24 a. m.	707.6	— 0.2	74	wnw.	14.8	1,656	612.9	— 9.6	100	wnw.	....
10:08 a. m.	707.6	1.1	62	nw.	12.5	2,328	562.0	—13.5	65	nw.	....
10:30 a. m.	707.8	1.8	60	nw.	14.8	3,104	508.0	—18.0	55	wnw.	....
10:37 a. m.	707.8	1.2	59	nw.	15.6	3,367	491.2	—16.8	48	wnw.	....
10:58 a. m.	707.9	1.4	54	wnw.	11.2	3,901	457.5	—20.4	38	wnw.	....
11:40 a. m.	708.1	2.2	56	wnw.	14.3	3,708	469.4	—20.4	38	wnw.	....
11:51 a. m.	708.2	2.8	56	wnw.	14.8	3,446	486.2	—19.0	38	wnw.	....
11:59 a. m.	708.2	2.3	54	wnw.	16.1	3,240	499.1	—19.4	38	wnw.	....
12:25 p. m.	708.2	2.1	53	wnw.	14.8	2,804	528.7	— 16.7	51	wnw.	....
12:56 p. m.	708.2	2.3	49	wnw.	10.3	2,258	567.9	—13.8	76	wnw.	....
1:15 p. m.	708.2	1.8	53	wnw.	10.3	2,088	580.6	—11.9	86	wnw.	....
1:38 p. m.	708.2	2.2	58	wnw.	15.2	1,621	616.8	— 8.1	70	wnw.	....
1:50 p. m.	708.2	2.9	47	wnw.	15.2	1,159	654.1	— 4.4	69	wnw.	....
2:01 p. m.	708.2	2.4	50	wnw.	14.3	880	677.6	— 2.3	60	wnw.	....
2:10 p. m.	708.2	2.7	50	wnw.	14.3	526	708.2	2.7	50	wnw.	14.3
Mar. 31.											
1:35 p. m.	714.4	4.0	50	nw.	17.0	526	714.4	4.0	50	nw.	17.0
1:43 p. m.	714.4	4.2	48	nw.	17.0	849	686.4	— 0.6	58	nw.	....
1:58 p. m.	714.2	4.1	51	nw.	17.0	1,183	658.0	— 3.7	77	nw.	....
2:42 p. m.	714.2	5.2	47	nw.	16.1	1,599	624.6	— 6.2	82	nw.	....
2:50 p. m.	714.2	5.3	47	nw.	16.1	1,190	657.6	— 3.4	83	nw.	....
3:30 p. m.	714.2	5.4	48	nw.	17.9	836	687.4	0.4	61	nw.	....
3:39 p. m.	714.2	5.0	47	nw.	16.1	526	714.2	5.0	47	nw.	16.1

March 29, 1909.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 7,500 m.; at maximum altitude, 6,700 m.

A few Cu. moving from the west-northwest at the beginning. These increased to 4/10 by the end of the flight. The base of the clouds was about 2,550 m. above sea level.

High pressure was central over Montana and low pressure over New Brunswick, with a minor depression over southern Texas.

March 30, 1909.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 8,000 m., at maximum altitude.

From 5/10 to 9/10 St.-Cu. moving from the west-northwest. Light snow fell from 9:08 to 9:55 a. m., and after 1:13 p. m. The head kite was in the clouds from 9:10 to 9:53 a. m., from 10:06 to 10:44 a. m., and at intervals thereafter until 1:30 p. m.; entering the clouds at an altitude of 1,800 m. and emerging at 1,650 m.

High pressure was central over Saskatchewan and low pressure over New Brunswick.

March 31, 1909.—Two kites were used; lifting surface, 10.8 sq. m. Wire out, 3,000 m.; at maximum altitude, 2,900 m.

About 7/10 St.-Cu. moving from the northwest at the beginning of the flight, but they had diminished to 3/10 by the end.

An extensive area of high pressure was central over Nebraska. Pressure was low over New Brunswick.

FIG. 9.—Wind observations in highs 526 meters above sea level.

FIG. 10.—Wind observations in highs 1,000 meters above sea level.

FIG. 11.—Wind observations in highs 2,000 meters above sea level.

FIG. 12.—Wind observations in highs 3,000 meters above sea level.

FIG. 13.—Means of wind observations in highs 526 meters above sea level

FIG. 14.—Means of wind observations in highs 1,000 meters above sea level.

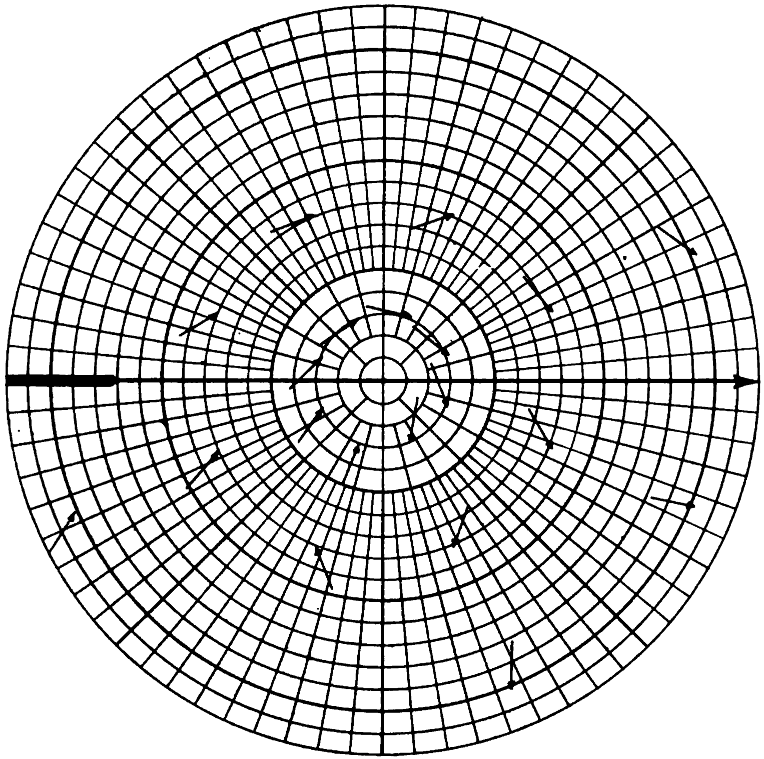


FIG. 15.—Means of wind observations in highs 2,000 meters above sea level.

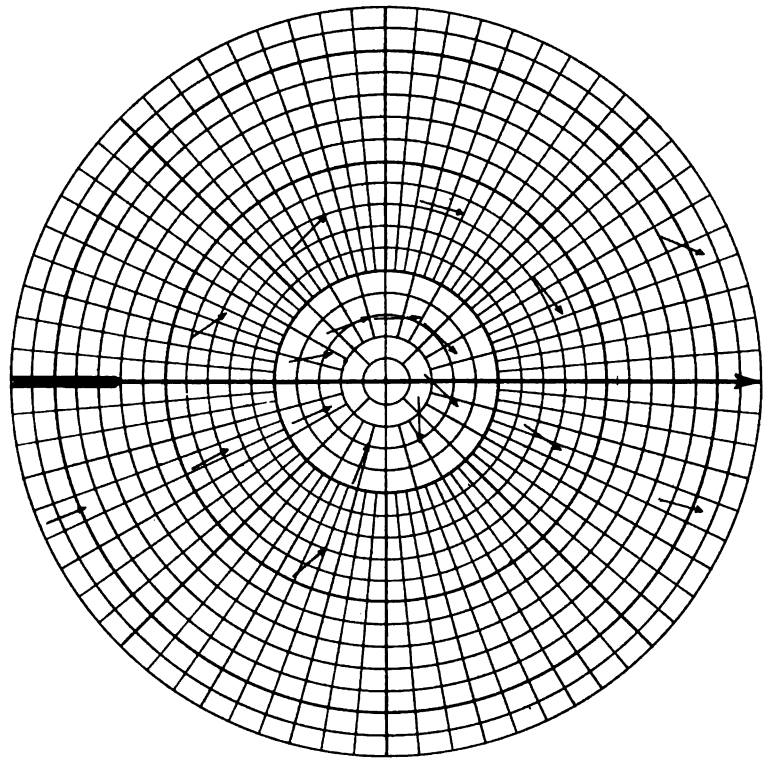


FIG. 16.—Means of wind observations in highs 3,000 meters above sea level.

FIG. 17.—Means of wind observations in highs 4,000 meters above sea level.

Fig. 18.—Wind observations in lows 526 meters above sea level.

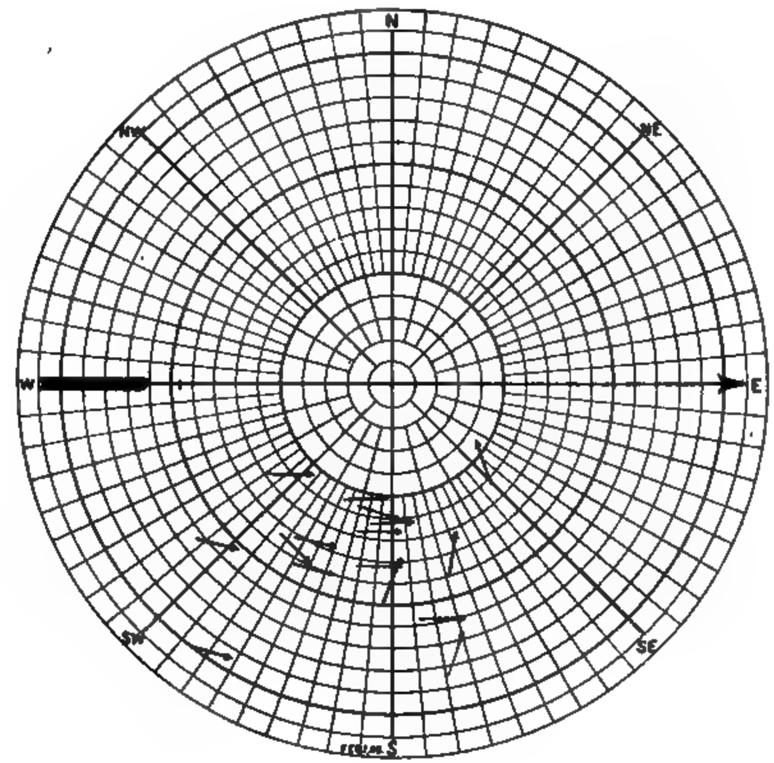


Fig. 19.—Wind observations in lows 1,000 meters above sea level.

FIG. 20.—Wind observations in lows 2,000 meters above sea level.

FIG. 21.—Wind observations in lows 3,000 meters above sea level.

FIG. 22.—Means of wind observations in lows 526 meters above sea level.

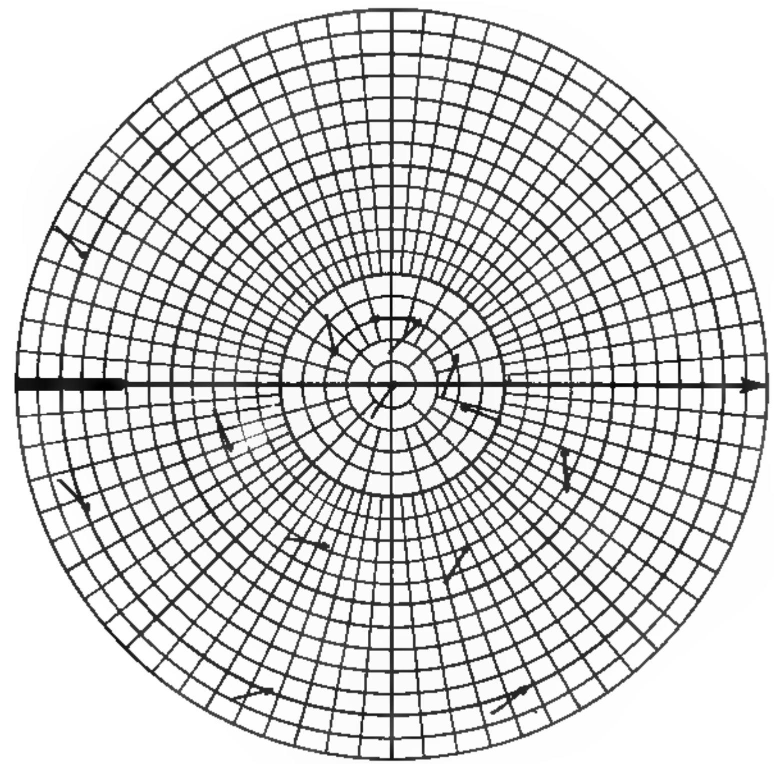
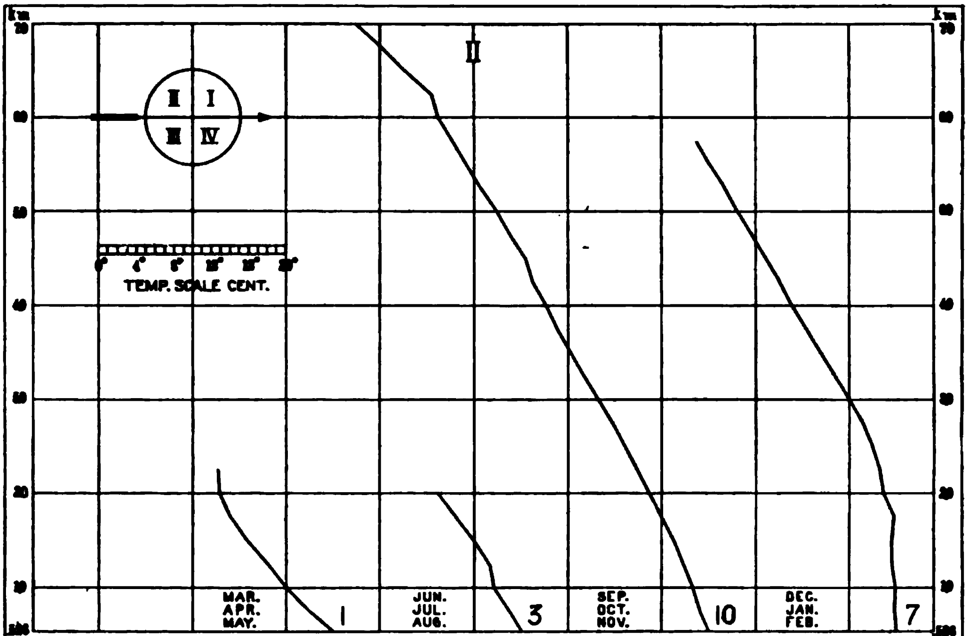


FIG. 23.—Means of wind observations in lows 1,000 meters above sea level.

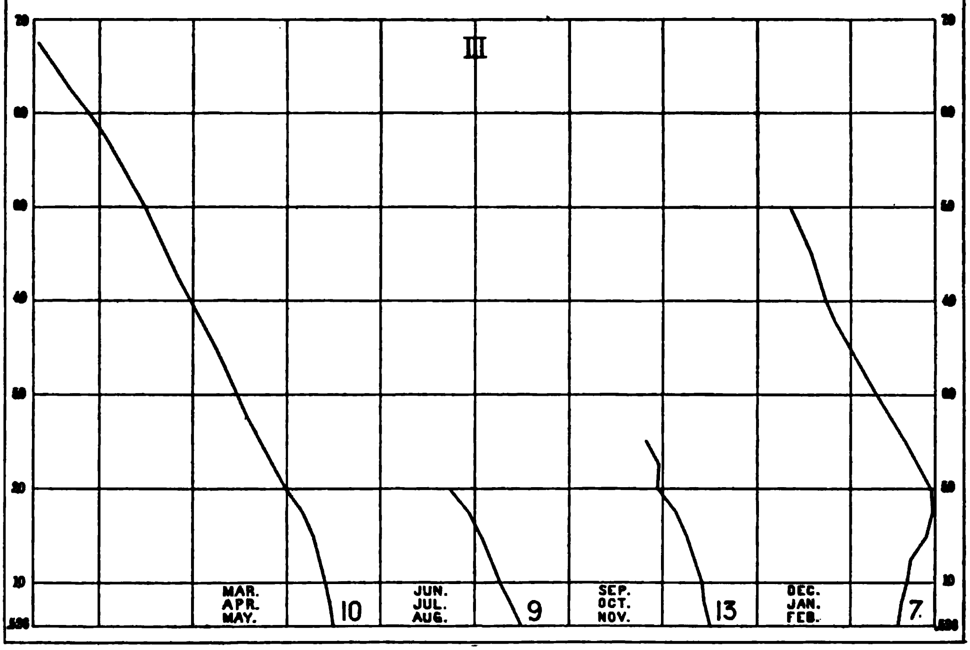
FIG. 24.—Means of wind observations in lows 2,000 meters above sea level.

FIG. 25.—Means of wind observations in lows 3,000 meters above sea level.



km
II
I
III
IV
TEMP. SCALE CENT.
MAR.
APR.
MAY.
1
JUN.
JUL.
AUG.
3
SEP.
OCT.
NOV.
10
DEC.
JAN.
FEB.
7

Fig. 27.



III
MAR.
APR.
MAY.
10
JUN.
JUL.
AUG.
9
SEP.
OCT.
NOV.
13
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JAN.
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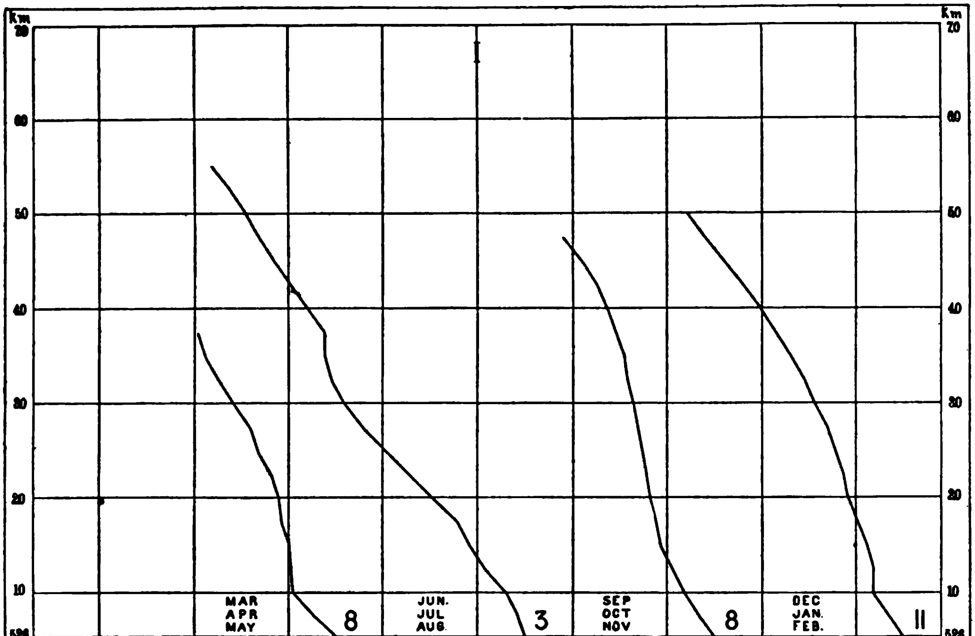
Fig. 28.


Km
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MAR
APR
MAY
8
JUN.
JUL
AUG.
3
SEP
OCT
NOV
8
DEC
JAN.
FEB.
11

Fig. 28.

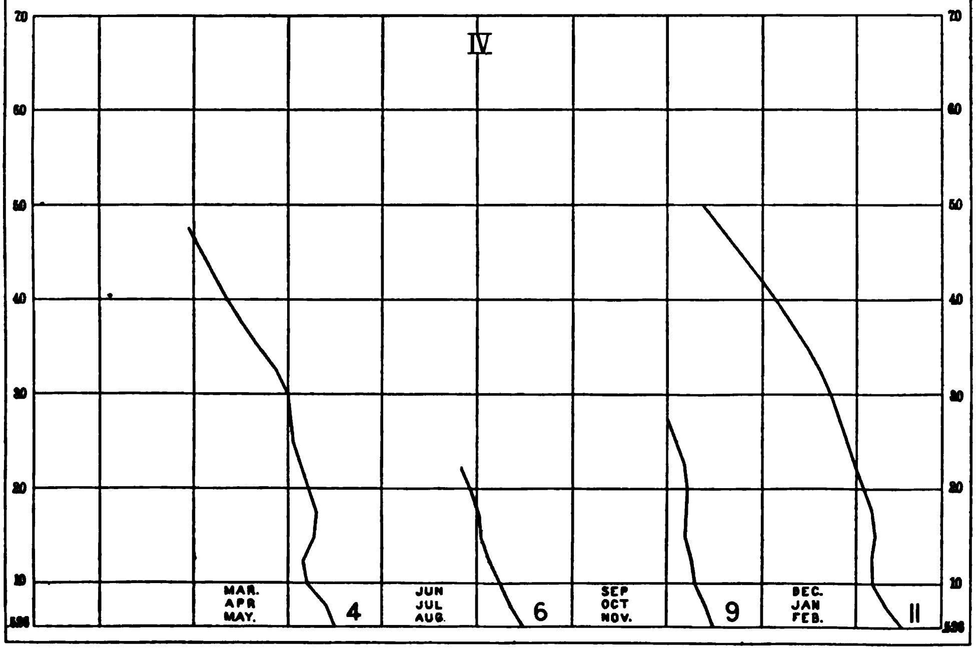
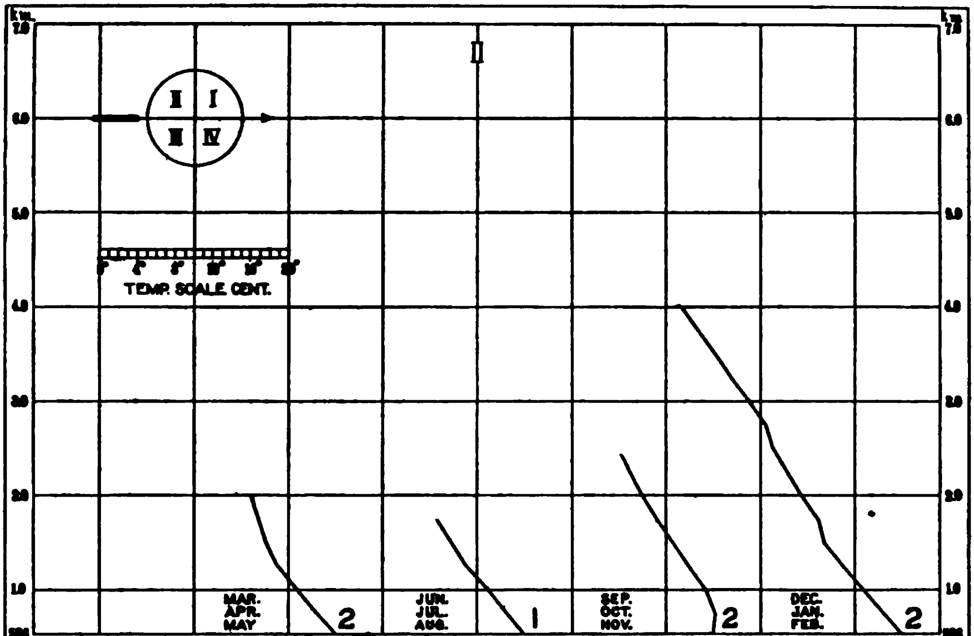

IV
MAR.
APR
MAY.
4
JUN
JUL
AUG.
6
SEP
OCT
NOV.
9
DEC.
JAN
FEB.
11

Fig. 29.


km.
7.0
6.0
5.0
4.0
3.0
2.0
1.0
II
I
III
IV
TEMP. SCALE CENT.
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APR.
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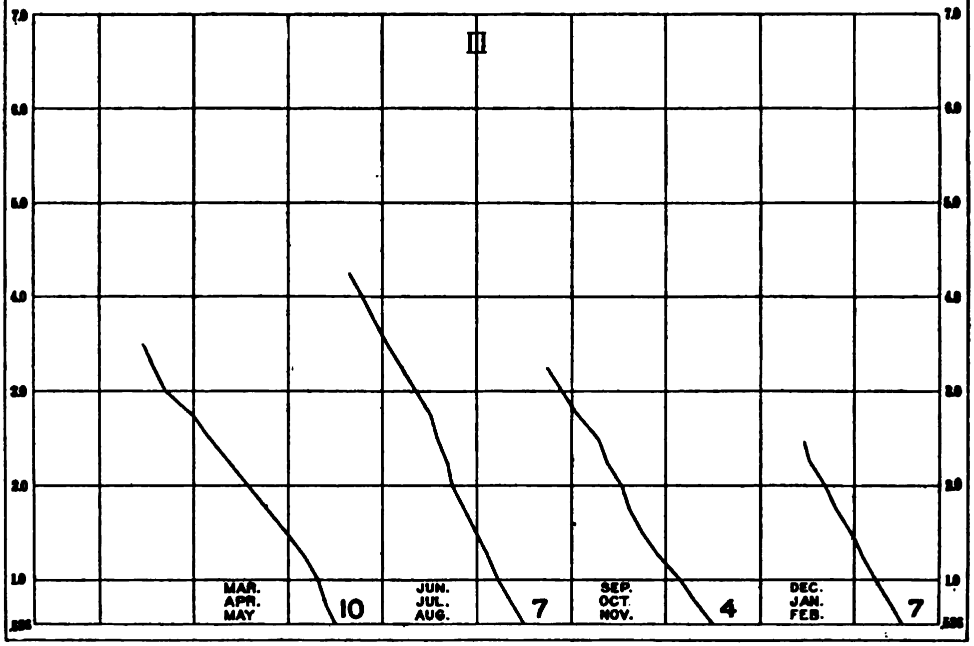
JUN.
JUL.
AUG.
1
SEP.
OCT.
NOV.
2
DEC.
JAN.
FEB.
2

Fig. 31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III
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JAN.
FEB.
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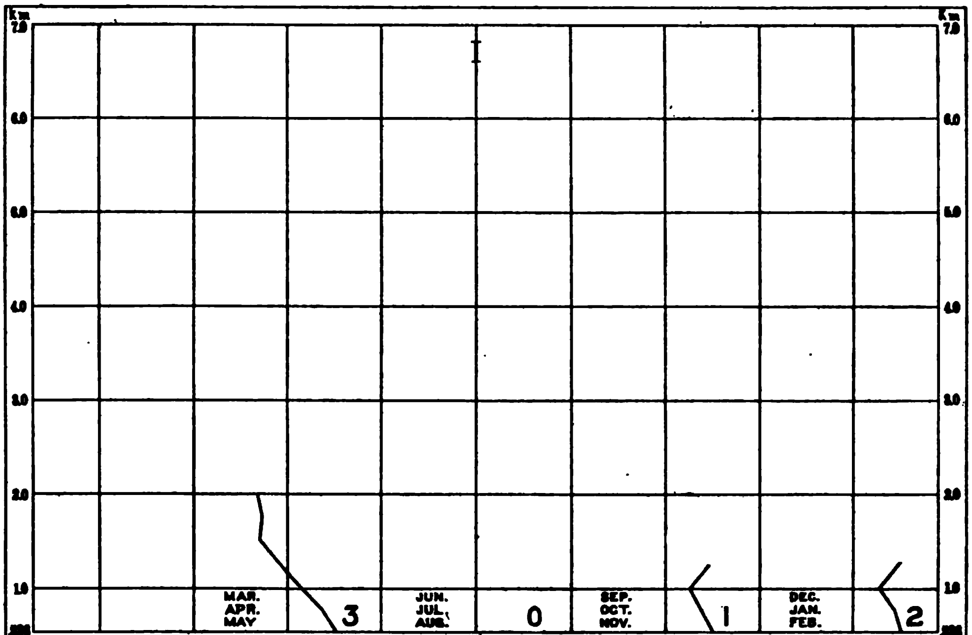
Fig. 32


Km
7.0
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1.0
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MAY
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Fig. 30.

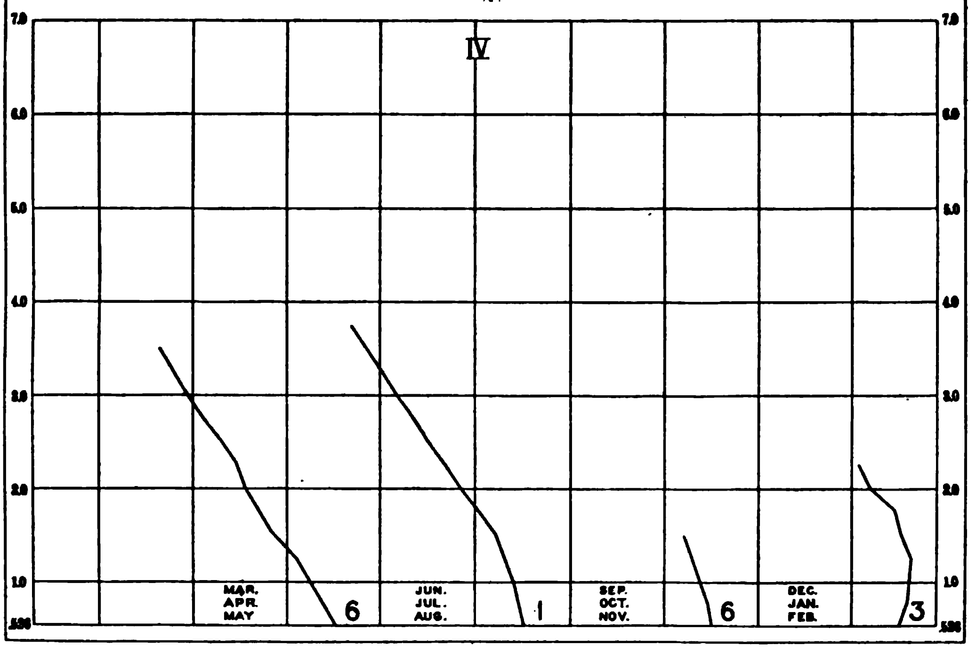

7.0
6.0
5.0
4.0
3.0
2.0
1.0
IV
MAR.
APR.
MAY
6
JUN.
JUL.
AUG.
1
SEP.
OCT.
NOV.
6
DEC.
JAN.
FEB.
3

Fig. 33.

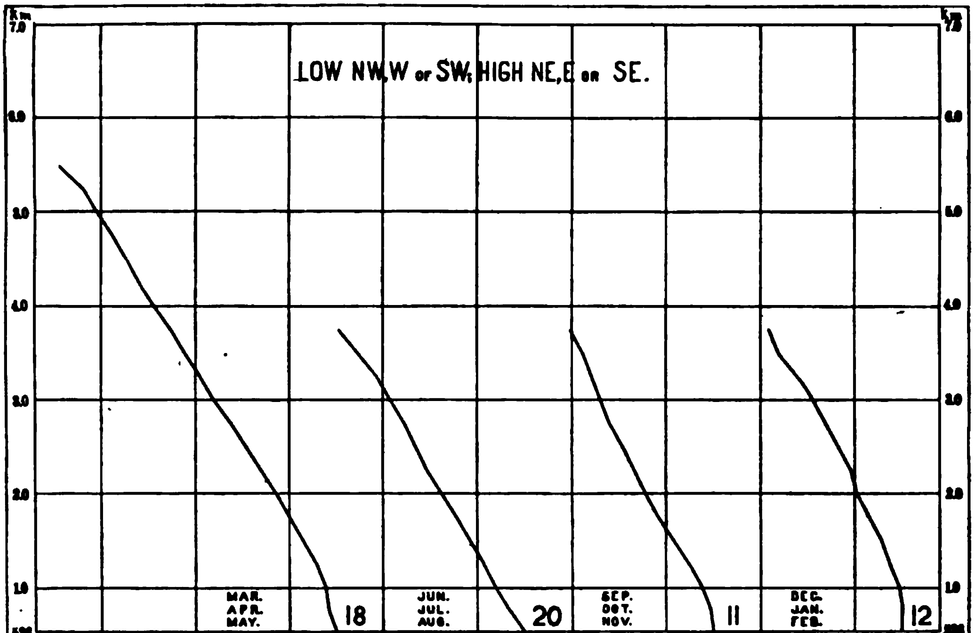
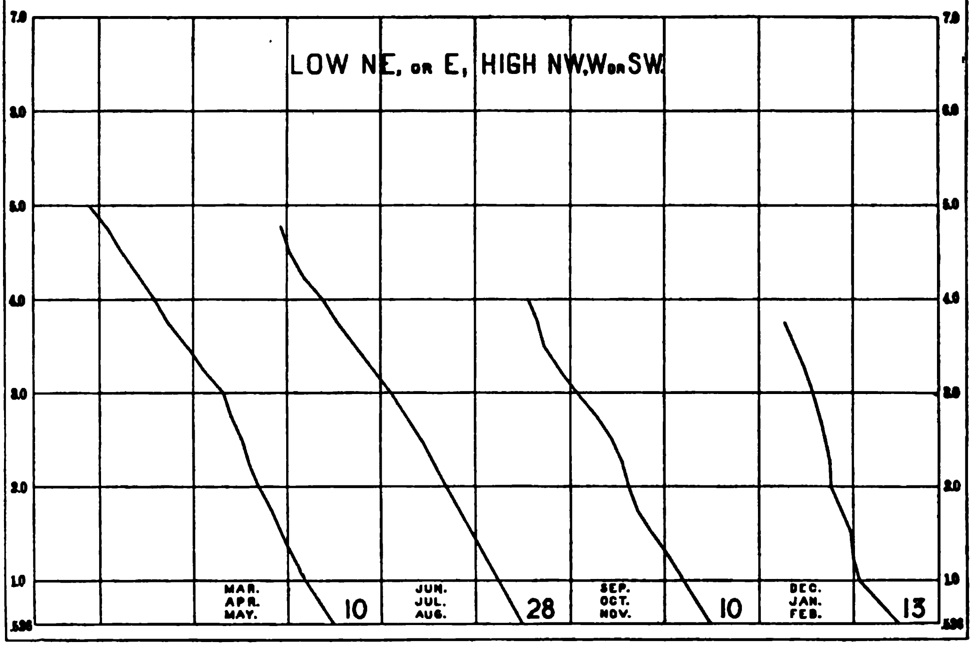

km
7.0
LOW NW,W or SW; HIGH NE,E or SE.
6.0
5.0
4.0
3.0
2.0
1.0
MAR.
APR.
MAY.
18
JUN.
JUL.
AUG.
20
SEP.
OCT.
NOV.
11
DEC.
JAN.
FEB.
12

Fig. 34.


7.0
LOW NE, or E, HIGH NW,W or SW.
6.0
5.0
4.0
3.0
2.0
1.0
MAR.
APR.
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JUL.
AUG.
28
SEP.
OCT.
NOV.
10
DEC.
JAN.
FEB.
13

Fig. 35.

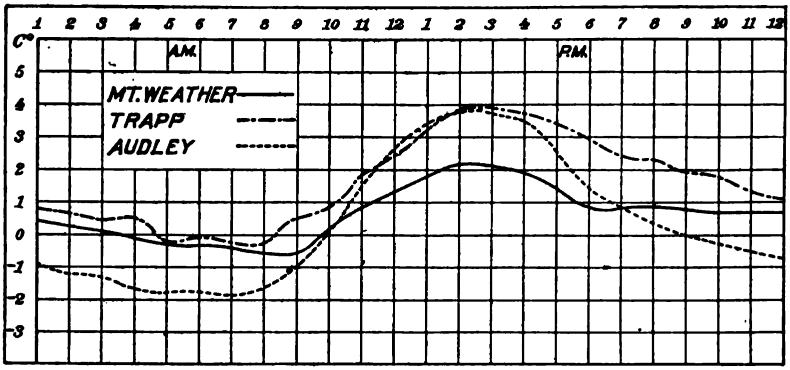


FIG. 36.—Maen hourly temperatures. January, 1909.

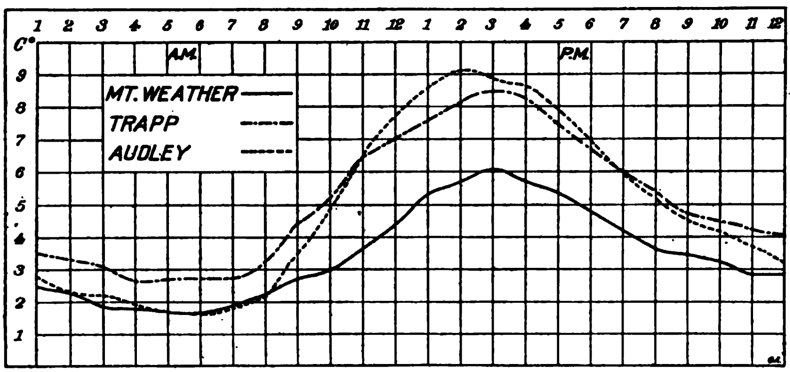


FIG. 37.—Mean hourly temperatures, February, 1909.

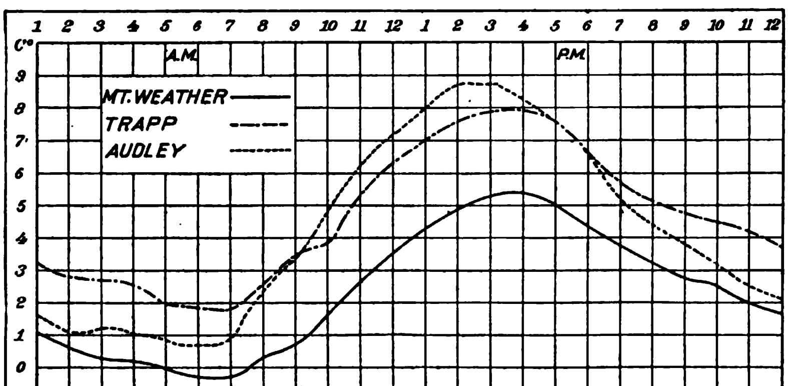
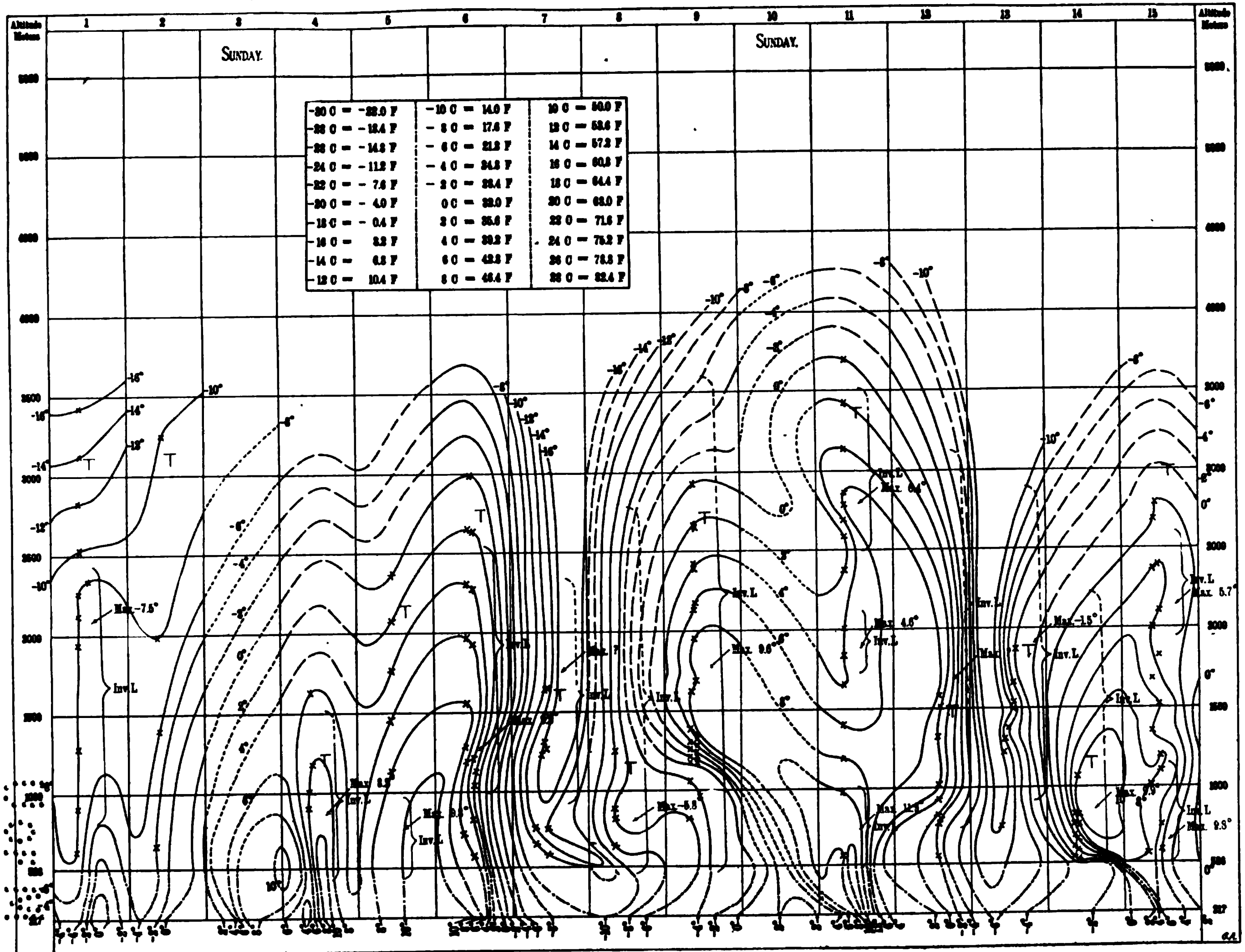
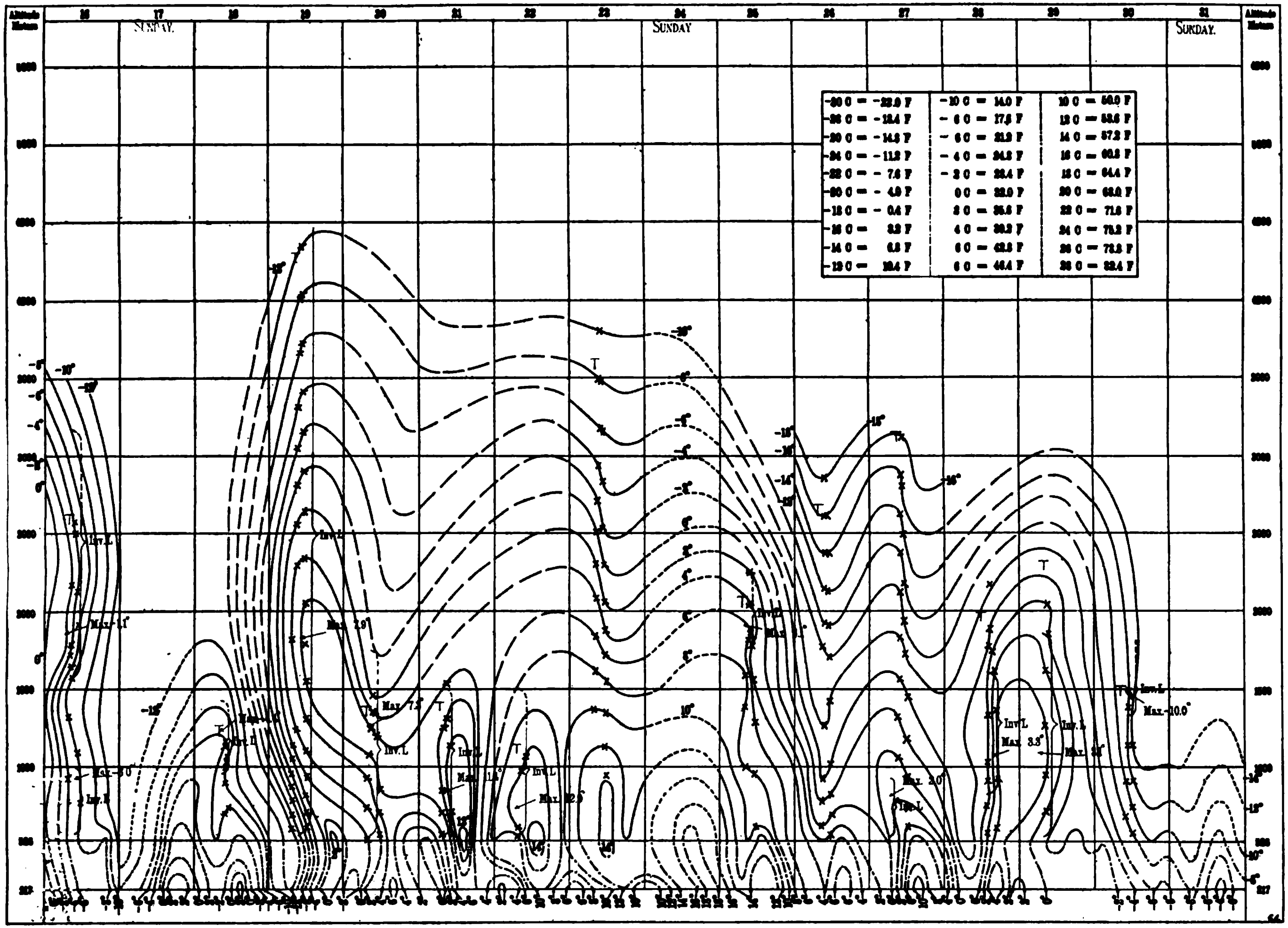


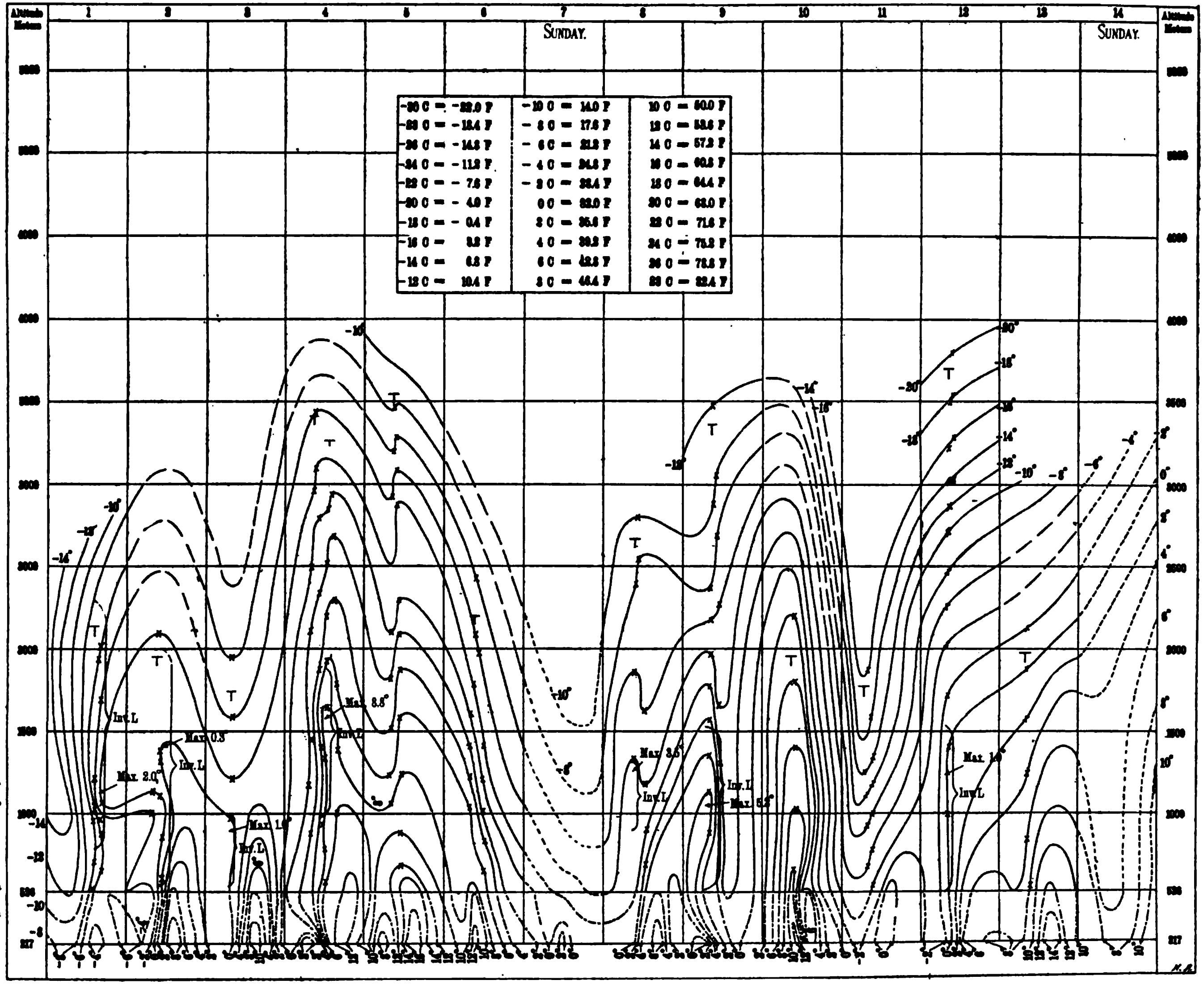
FIG. 38.—Mean hourly temperatures, March, 1909.



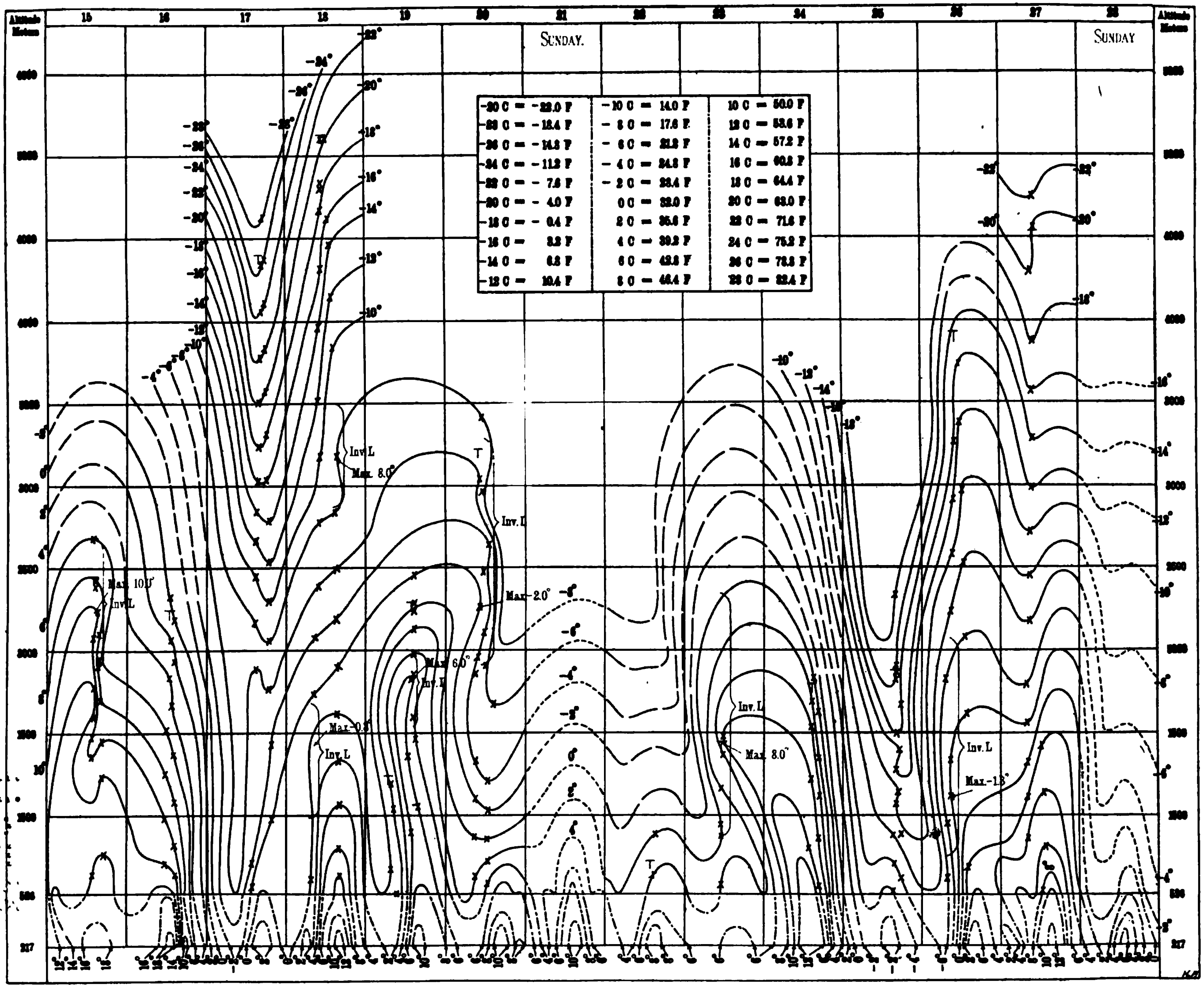
Upper air isotherms, January 1-15, 1909.



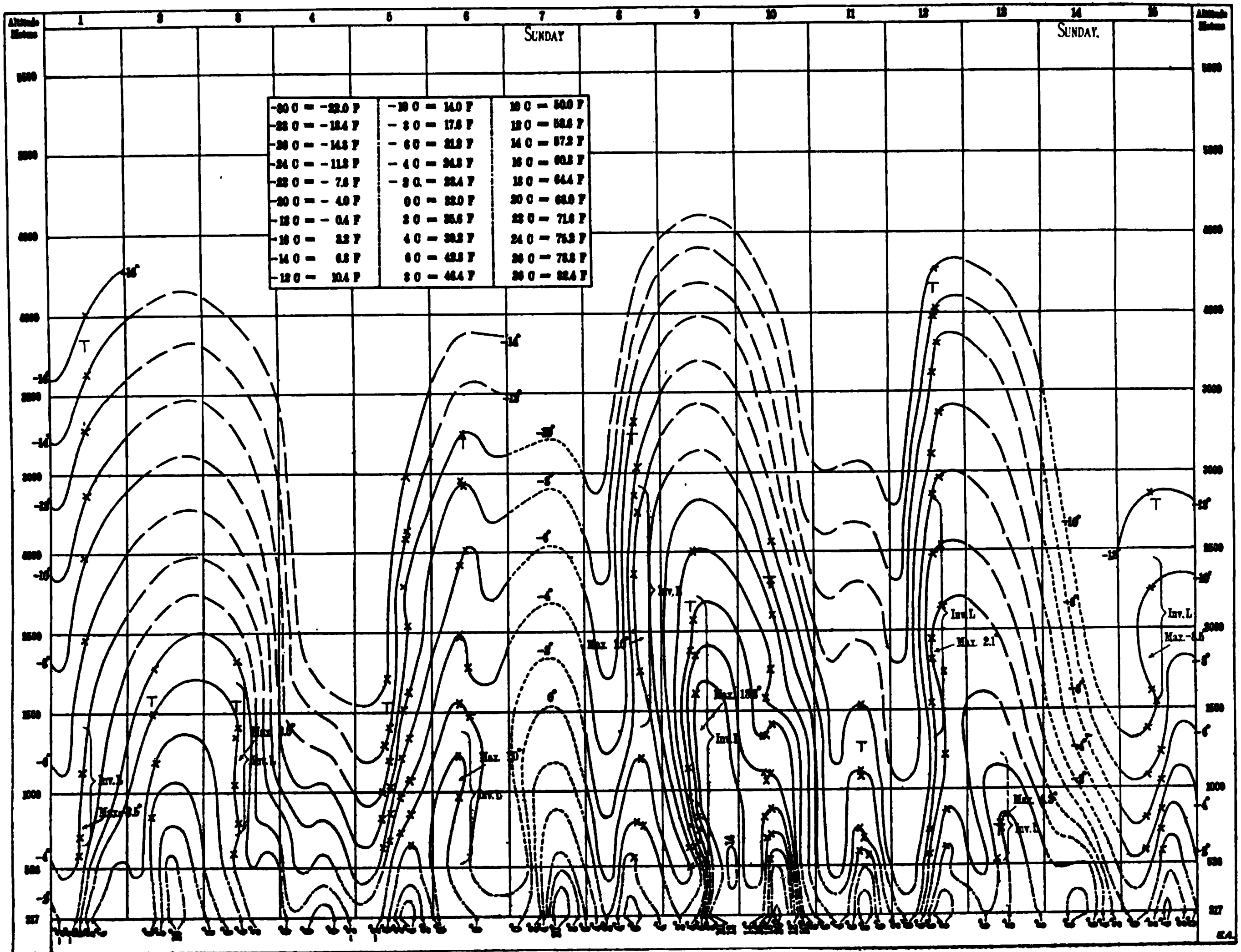
Upper air isotherms, January 16–31, 1909.



Upper air isotherms, February 1–14, 1909.

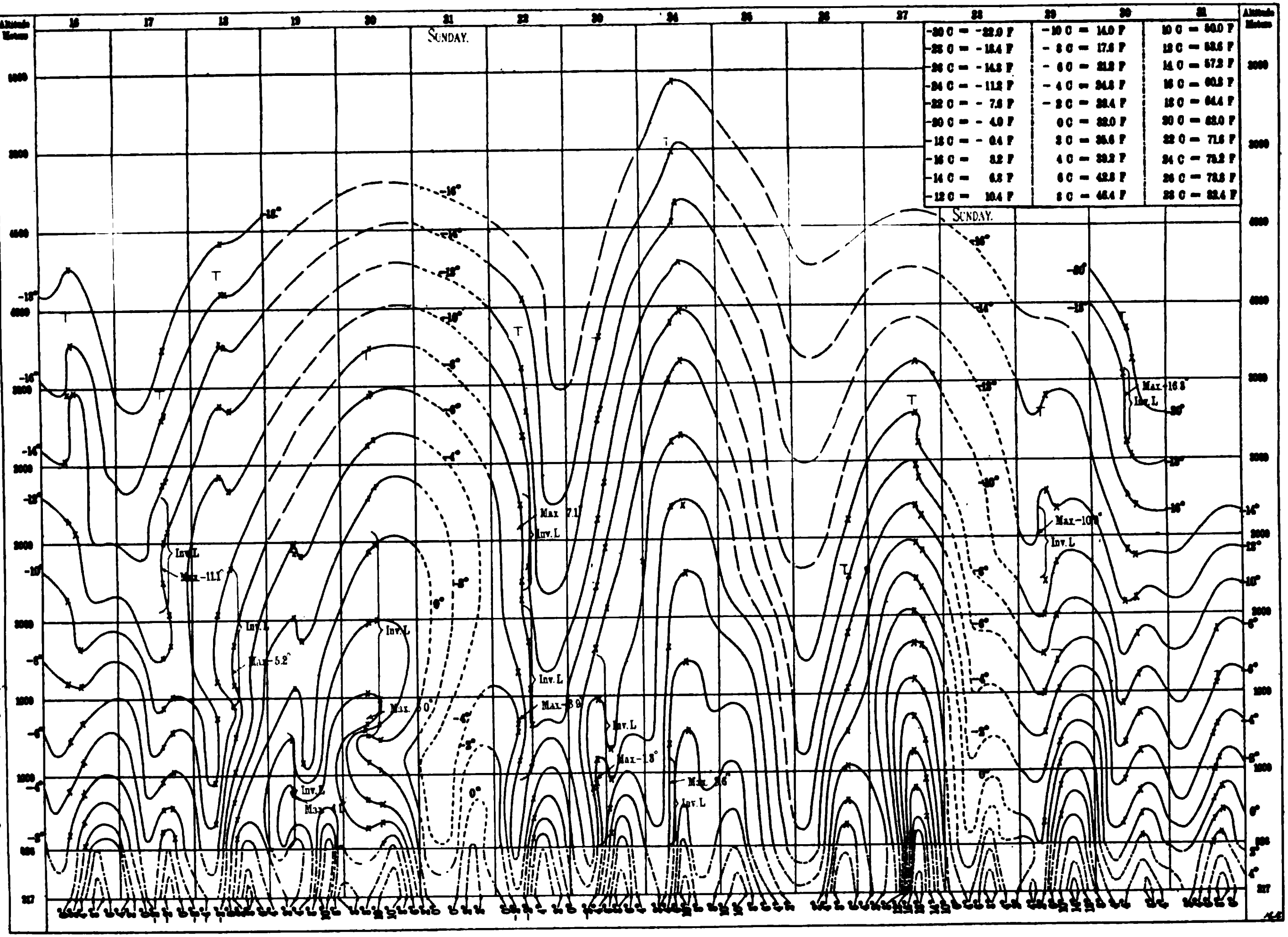


Upper air isotherms, February 15–28, 1909.



Upper air isotherms, March 1-15, 1909.

Chart XVIII.



Upper air isotherms, March 16–31, 19 09.

W. B. No. 427. Date of issue, April 30, 1910.

U. S. DEPARTMENT OF AGRICULTURE

Vol. II

BULLETIN

Part 4

OF THE

MOUNT WEATHER OBSERVATORY

PREPARED UNDER THE DIRECTION OF
WILLIS L. MOORE, D. Sc., LL. D.
CHIEF U. S. WEATHER BUREAU

WASHINGTON
GOVERNMENT PRINTING OFFICE
1910

CONTENTS.

ILLUSTRATIONS.

CLEVELAND ABBE,
Professor and Editor.

CIRCULAR LETTER TO TECHNICAL METEOROLOGISTS.

[The following is the text of a letter addressed by the Chief of Bureau to meteorologists and is published for the information of all who are willing to contribute to the pages of this Bulletin.]

The successive numbers of the Bulletin of the Mount Weather Observatory have thus far been filled principally by contributions from members of the scientific staff of the U. S. Weather Bureau, but it is not desired to impose such limitation on it. I am authorized to say that the scope of the Bulletin will cover the technical discussion of any problem bearing on the physics of the earth's atmosphere. All students of meteorology are cordially invited to submit for publication therein such researches, observations, or comments as have a bearing on any phase of the physics of the atmosphere. Communications in the English language are specifically desired; those made in other languages will be translated subject to the approval of the authors. Authors of memoirs too long for publication in this Bulletin are respectfully invited to communicate authoritative summaries or abstracts. It is desired to make this periodical as useful among English-speaking meteorologists as the corresponding bulletins, journals, and official publications in other languages have become to our colleagues of other nations.

In accordance with a recent announcement in the Monthly Weather Review, that publication will hereafter be confined to climatological data and the relations between climatology and practical problems in engineering, hygienics, or agriculture. On the other hand, the Bulletin of the Mount Weather Observatory will be specifically devoted to a field not now covered by any American journal, i. e., research and progress in aerology and all that higher physical meteorology to which we must look for future improvements in our forecasts of daily and seasonal weather.

VERTICAL TEMPERATURE GRADIENTS AS MODIFIED BY SEASONS AND BY STORM CONDITIONS.

By W. J. Humphreys.[a]

GENERAL REMARKS.

From the many observations that have been made with sounding balloons we know that the temperature of the air decreases with ascent, often irregularly near the surface and then rather uniformly, until, in middle latitudes, an elevation of 10 to 12 kilometers is reached, where it becomes essentially constant. The temperature records obtained in this way, though alike in their main features, differ from each other in details, of which some appear to be only fortuitous while others clearly accompany definite conditions of storm or season.

It is these storm and seasonal effects with which the present paper is concerned; and for this study only European observations have been used, for the reason that for no other place are the published data sufficiently numerous, nor do they cover a sufficient length of time, to justify conclusions in regard to the exact nature of storm and seasonal effects. Presumably the vertical temperature gradients of Europe are, in general, like those of other continents, but how nearly their storm and seasonal peculiarities agree with those produced under similar circumstances in other parts of the world, over land and over sea, is an important matter that observation has yet to decide. It must therefore be understood that the conclusions reached by this particular study extend, with certainty, to only the atmosphere over Europe, though probably most of them, if not all, are of much wider, perhaps even universal application.

SEASONAL EFFECTS.

The seasons selected for this study are summer (June, July, August, and September) and winter (December, January, February, and March). Spring and fall observations were not used owing to the transitional nature of the seasons in which they were made—the

[a] Read by permission of the Chief of Bureau on August 19, 1909, before the Astronomical and Astrophysical Society of America.

overlapping and confusion of summer and winter conditions. Also, since change of latitude during any given season is of the same general nature as change of season at any given latitude, therefore to reduce as far as possible confusion of causes only those observations were used that were obtained at stations that have about the same latitude. These are Munich, Strassburg, Trappes, and Uccle.

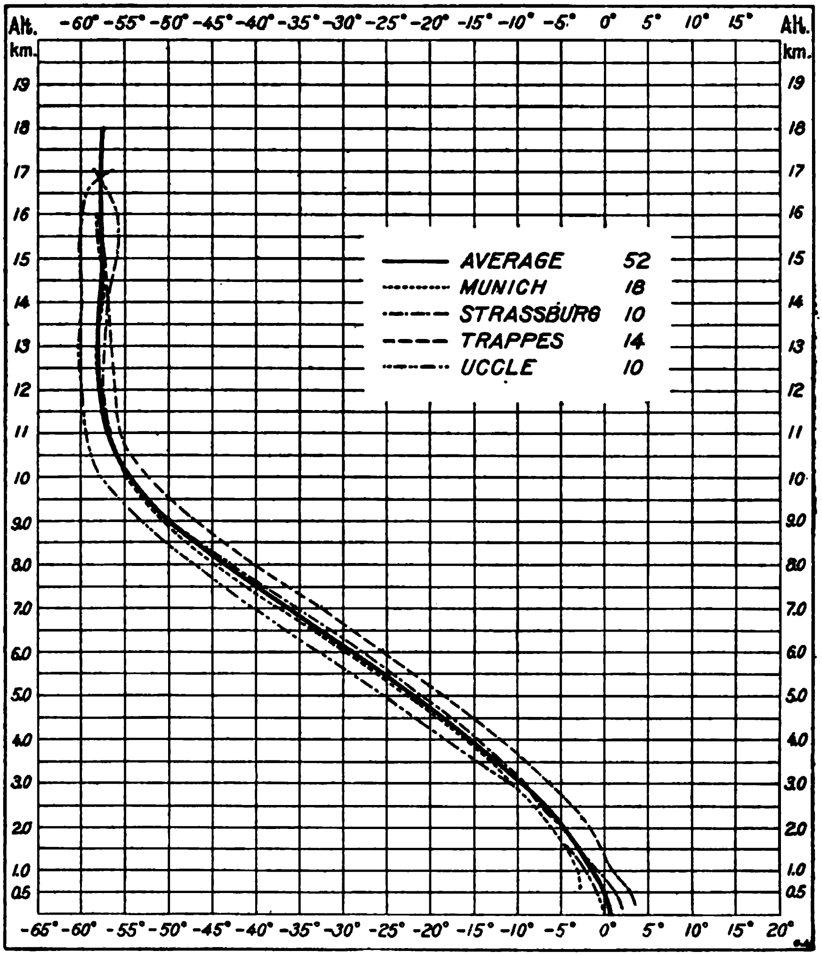


FIG. 1.—Average winter gradients.

All available data from these several stations was used, that is, for winter, the results of 18 flights made at Munich, 10 at Strassburg, 14 at Trappes, and 10 at Uccle. The average vertical temperature gradients of these several groups of winter flights are given in the broken and dotted lines of figure 1, and the weighted means of these in turn in the heavy continuous line. It will be noticed that all these average

gradients parallel each other closely, but that there is an appreciable difference between the temperatures obtained at Trappes and at Uccle. This difference, however, persists from the surface of the ground to well up in the isothermal region, and therefore, presumably, whatever is its cause at one level is also its cause at all others. The Trappes and the Uccle data do not all belong to the same years and

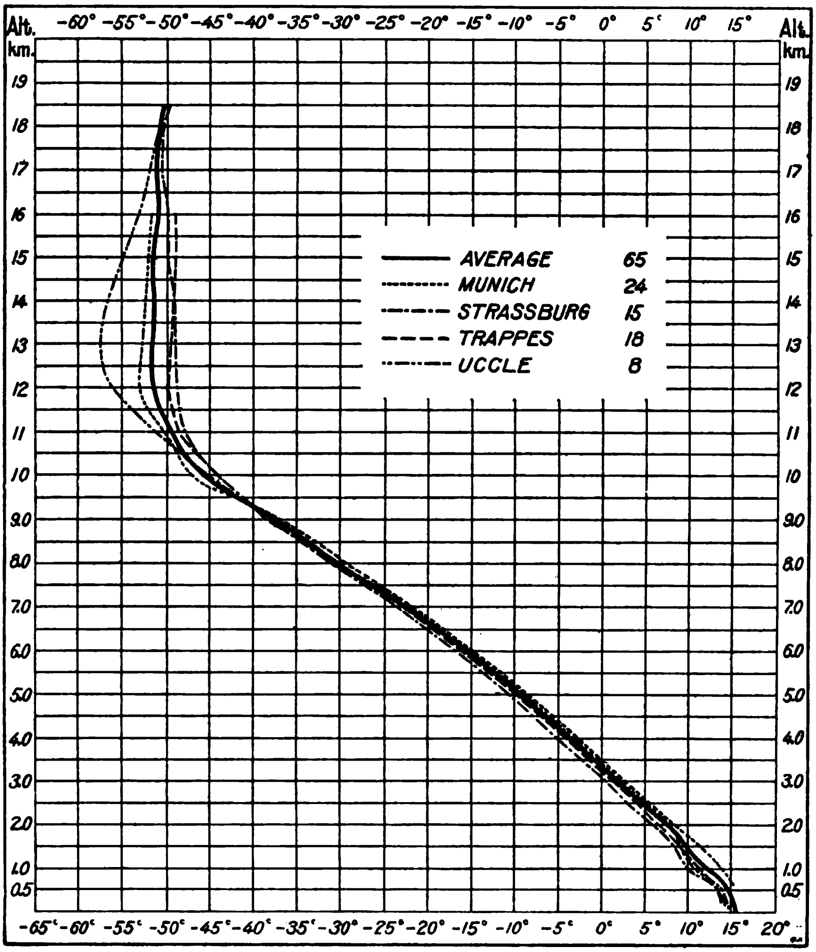


FIG. 2.—Average summer gradients.

similar storm conditions, and, besides, the average winter surface temperature is somewhat higher at Trappes than at any of the other stations. Probably these two facts account in the main for the differences noted.

Figure 2 gives the average summer temperature gradients as obtained from 24 flights made at Munich, 15 at Strassburg, 18 at

Trappes, and 8 at Uccle. In this case the average gradients of the several stations follow each other very closely except for the considerable departure of the Uccle curve from the others in the isothermal region. This departure is due to a few unusually low temperature readings, and presumably an average of a large number of summer flights from Uccle would show no such unexpected departures.

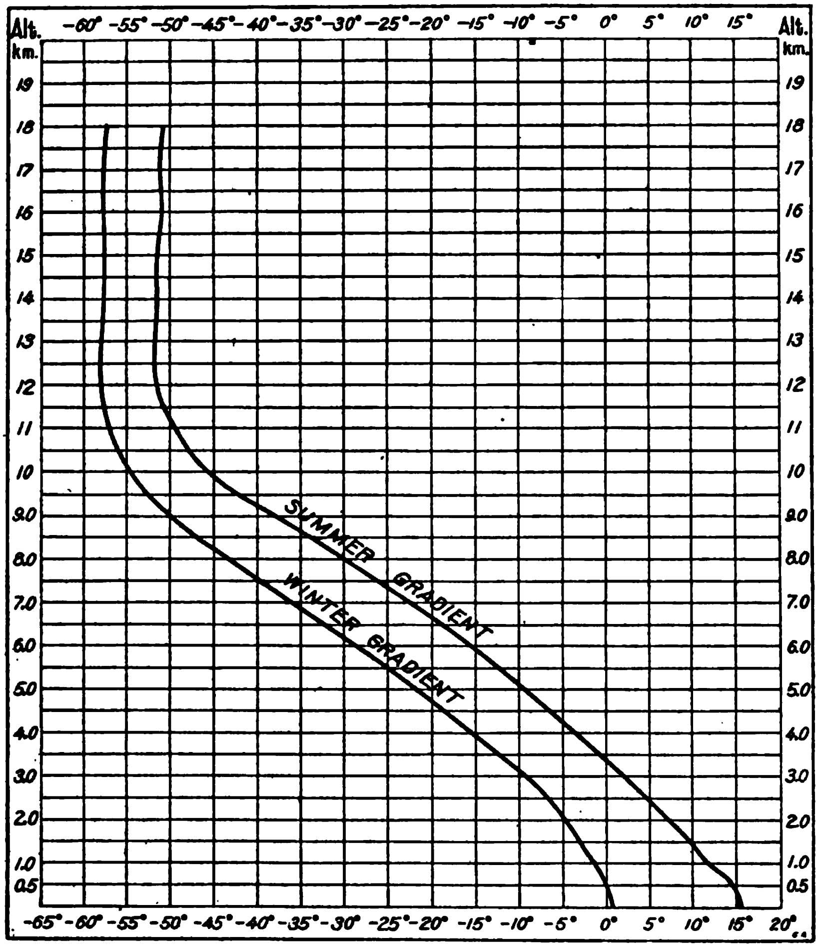


FIG. 3.—Average summer and winter gradients.

Figure 3 shows the full line curves of figures 1 and 2, or the averages of 52 winter and 65 summer vertical temperature gradients obtained by sounding balloon flights from the four stations mentioned.

According to these observations the average winter to summer temperature difference is about 15° C. at the ground, roughly 12° C. from an elevation of 2 kilometers up nearly to the isothermal layer,

in which it still persists even to the greatest altitudes reached, though here amounting to only some 7° C., or about half the surface difference. Up to 2½ kilometers, or thereabouts, the temperature falls less rapidly with increase of elevation during the winter than it does in the summer, while from 4 to 8 kilometers the average fall is somewhat more rapid in the winter. It will be noticed, too, that the average height of the upper inversion is a little less in winter than in summer, and, further, that the winter average temperature curve passes more gradually than does the summer one from the convective to the isothermal region. The gentle change in slope of both curves as they pass into the isothermal region, in contrast with the abruptness shown by individual flights, is largely due to averaging together gradients that invert at widely different elevations—elevations that differ more in the winter than in the summer and which therefore, when averaged together, produce for the colder season a curve of larger radius.

During the summer the surface of the earth receives more solar energy and grows warmer than it does during the winter, and therefore the entire atmosphere above it also is warmest during this season. The surface air is heated largely by direct contact; that at moderate elevations partly through increase of radiation and partly by convection; that of the isothermal region chiefly by increase of terrestrial radiation.

If we let T_1 be the absolute temperature of the upper air, and T_0 the effective temperature of the lower atmosphere or the temperature of an equivalently radiating black surface, then we can write

$$T_1 = kT_0,$$

in which the value of k, always less than unity, depends mainly upon the composition of the upper atmosphere and upon the kind of radiation supplied; but in general k may be supposed to remain nearly constant at any given place, and therefore the greater T_0, or the effective temperature of the lower atmosphere, the greater also T_1, or the temperature in the isothermal region.

We may also write

$$h = (T_0 - T_1)s,$$

in which h is the height of the upper inversion above the effective temperature level, or the level of the atmosphere whose temperature is T_0, and s the average change in height corresponding to a difference of 1 degree of temperature in the convective region—an approximate constant.

On substituting for T_1 its value in terms of T_0, we obtain

$$h = (T_0 - kT_0)s = (1 - k)sT_0,$$

and therefore, other things being equal, not only is the temperature

of the isothermal region greatest when the radiation from below is a maximum, but also the level of its under surface, the upper inversion, is at the greatest elevation.

STORM EFFECTS.

As just seen, the average of a season's (winter or summer) gradients gives a fairly regular curve, and of course the same would be true of the average of these averages, or of what might be called the annual gradient for any given locality. However, each particular flight yields its own temperature-altitude curve, that differs more or less from others of the same place and season, especially in the values of the gradients in the first 2 or 3 kilometers elevation, in the absolute temperatures at other levels, and in the location of the upper inversion.

With the view of determining the causes of some of these flight-to-flight irregularities, I have grouped both summer and winter temperature gradients into highs, lows, and neutrals, according to the atmospheric pressures at the times and places of the observations. Thus the "highs" belong to barometric readings of 765 mm. or more; the "neutrals" to readings from 757.5 mm. to 762.5 mm.; the "lows" to readings of 755 mm., or less, all reduced to sea level. For this study I have used all the published records obtained at Lindenberg, Munich, Strassburg, Trappes, Uccle, and Zurich. While the observations, especially those classed as lows, are not sufficiently numerous to give averages entirely free from irregularities, nevertheless they produce distinct types of curves that any larger number probably would but slightly modify.

Figure 4 shows the winter averages, respectively, of 32 highs, 13 neutrals, and 7 lows. Commonly, as the figure shows, a high barometer in the winter is accompanied by low surface temperatures, by a slow decrease of temperature up to an elevation of about 3 kilometers, by relatively warm air, in general, between the levels of 3 and 9 kilometers, by a high upper inversion, and by a cold isothermal region. A winter low, on the contrary, and in comparison with a high of the same season, brings a warm isothermal layer, a low inversion level, and a convective region that is cold everywhere except near the surface, at which place it is warm.

The normal barometer, as one would expect, is accompanied by intermediate values in all particulars.

The corresponding summer gradients (averages, respectively, of 35 highs, 41 neutrals, and 9 lows), given in figure 5, show, except near the surface, where the lows remain cold and the highs warm, the same characteristics as do those of winter.

Both the summer and the winter curves follow exactly the averages of the observations, except for slight deviations in the isothermal region, as shown. Naturally, the higher the level the fewer the observations secured, a fact that explains the irregularities in the iso-

thermal region and justifies, in a sense, smoothing the curves in an effort to distinguish clearly the different types of gradients.

It remains to find the explanation of these phenomena, to account for the observed differences in the temperature distributions in barometric highs and lows.

An obvious contributing cause of these differences in temperature, though not a sufficient one, is the warming of the air by compression

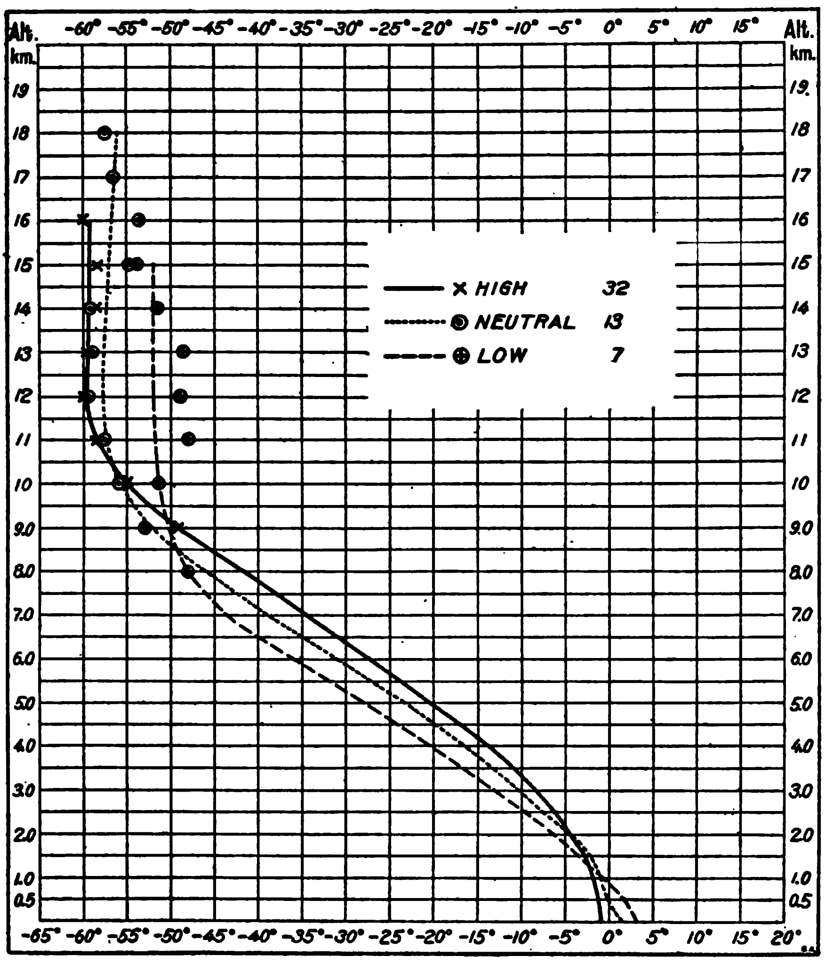


FIG. 4.—Average winter storm gradients.

and its cooling by expansion incident to barometric changes. A discussion of this phenomenon is given in Hann's Lehrbuch der Meteorologie, page 589, where it is shown that, when the temperature of dry air is 0° C., $\frac{dt}{dp}=\frac{78.7}{p}$, in which p is the pressure, expressed in millimeters of mercury, and dt the change in degrees centigrade.

According to figures 4 and 5 the temperature, both winter and summer, at the altitude of 4 kilometers, is, roughly, 7° C. warmer in the region of an average high barometer than it is in that of a low. But to secure this temperature difference as a result of pressure change only would require a rise or fall of the barometer at this level of about 40 mm., or something like 70 mm. at sea level. Therefore, since this is fully three times the average range of pressure, it is clear

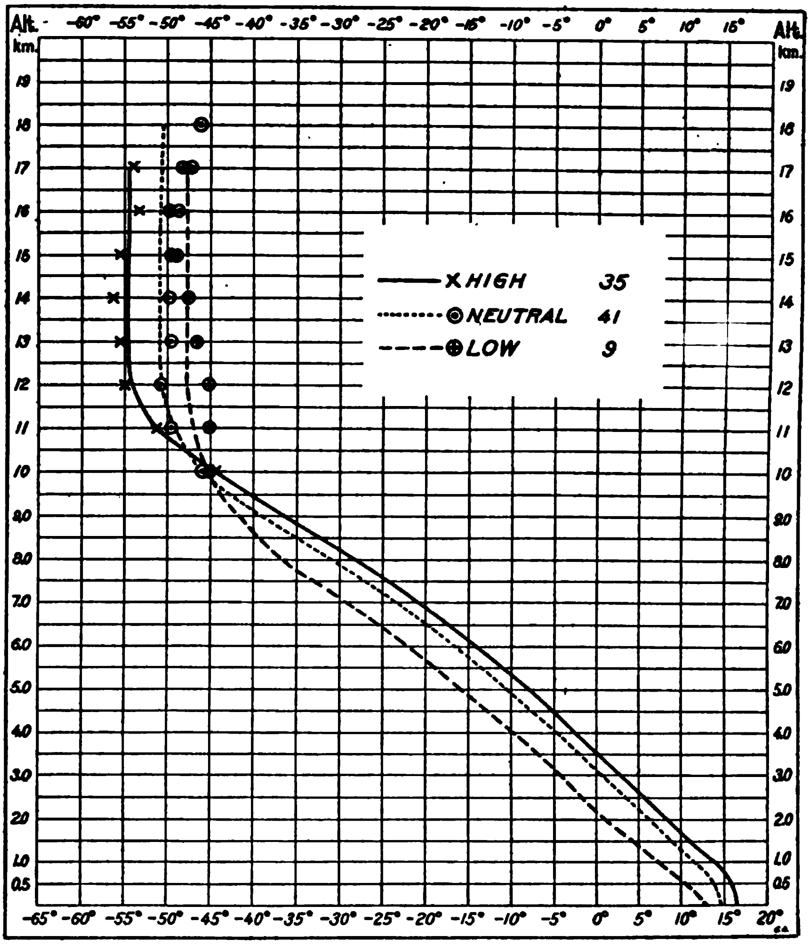


Fig. 5.—Average summer storm gradients.

that the observed temperature changes can not in the main be accounted for in this way, though of course the pressure effect must be present to some extent. Besides, it is not clear how a compression in the lower atmosphere sufficient to produce the observed difference in temperature could at the same time cause, or be accompanied by, a rarefaction in the isothermal region sufficient to secure the lower temperatures that prevail there when the barometer is high.

Another source of temperature changes, generally associated with the height of the barometer, is the clear and the cloudy condition of the sky, or the humid and the dry state of the atmosphere. A barometric high, as we know, commonly is accompanied by clear skies and a dry atmosphere, while in the region of a low the sky ordinarily is overcast, the atmosphere relatively moist, and precipitation abundant; conditions that have much to do with air temperatures. Thus, generally, at the end of any consecutive twenty-four hours of clear weather the surface of the earth will be warmer in the summer time and colder in the winter because of the unequal lengths during those seasons of the day and night. On the whole, the earth gains heat, especially in clear weather, during the summer and loses it in the winter. A cloud covering, however, checks this gain or loss, and therefore on the surface, in the winter, the temperature is lowest when the barometer is high and the earth can radiate most freely to space, while it is warmest when the barometer is low and the sky so overcast as to check radiation loss.

In the summer time, as explained, the conditions of gain and loss of heat are reversed, and therefore the highest surface temperatures accompany the high barometer, or clear weather.

When the barometer is distinctly above normal the temperature fall with increase of altitude, except near the surface, generally follows approximately the adiabatic curve for dry air. When, however, the barometer is low the temperature gradient usually is far less constant at all elevations, owing to irregularities in the humidity distribution and the consequent varying amounts and places of precipitation. In many cases the temperature gradient over varying heights is essentially the adiabatic curve for saturated air at the prevailing temperature and pressure—that is, a fall of temperature per given change in altitude that is less, other things being equal, the greater the amount of uncondensed humidity present.

Since the curves of figures 4 and 5 are the averages of several flights, it may be approximately correct, in an effort to account for their differences, to start with something like average conditions and trace the consequences. Let these conditions be a moist atmosphere in the one case and a dry one in the other, each having the same temperature as the other at all levels. The moist atmosphere, because a better radiator than the dry, will, under the same conditions of exposure and at the end of the same interval of time, cool to a lower temperature, but in so doing—that is, in getting rid of its own heat most rapidly—it therefore at the same time supplies heat at greater rate to any neighboring region that receives it by radiation only. Therefore when the lower atmosphere is moist it will, under like conditions, radiate heat most rapidly to and through the always dry air of the isothermal region, and while getting cold itself will at the same

time warm this region to a temperature above its average. On the contrary, in the region of a high barometer, the lower air, being relatively dry and therefore a poor radiator, will conserve its own temperature, but in so doing will allow the isothermal region to get cold in comparison with its temperature during the prevalence of a low at the same season.

SUMMARY.

I. At any given latitude the average temperature of the atmosphere is warmer during the summer than in the winter from the surface of the earth to the greatest altitudes attained by sounding balloons. This difference of temperature is due in the case of the lower levels to the seasonal difference in the amount of heat distributed to the atmosphere by conduction and convection, while the extension of this same condition (warmer in summer than in winter) to the nonconvective or isothermal region is largely due to the difference in the amount of heat that reaches it by radiation coming especially from the moisture in the air below.

II. A high barometer is accompanied, in general, by a cold isothermal region and by a warm lower atmosphere, the latter extending from near the level of the upper inversion down to about 2 kilometers above the surface of the earth in winter, and all the way down in summer.

III. A low barometer commonly is associated with a warm isothermal layer and a cold lower atmosphere that, in the summer, reaches the earth, but in winter extends down only to about the 2-kilometer level.

All these temperature inequalities that appear to be associated with barometric differences seem to be due in the main to the unequal radiating powers of moist and dry air—the former warming its neighbor, the air of the isothermal region, by a rapid supply of radiant energy, but by so doing itself getting cold; while the latter, or the dry air, being a poor radiator, conserves its own heat and therefore, while itself remaining warm, allows the isothermal region to grow colder because of the decrease in the supply of heat. In the isothermal region there is a nearly constant equality in the rate of supply and loss of heat by radiation. When a moist lower atmosphere follows a dry one the supply of heat by radiation to the air of this region for a time is greater than its corresponding loss, and its temperature rises. On the other hand, when a dry lower atmosphere succeeds a moist one the supply is less than the loss, and there is a corresponding cooling.

PERIODIC VARIATION IN THE VELOCITY OF THE CENTERS OF HIGH AND LOW PRESSURE.

By Ernest Gold, M. A. (dated London, February 13, 1909).

If we take the monthly values for the velocity of centers of high pressure given by von Herrmann (Monthly Weather Review, April, 1907, pp. 169–171[a]) we find

$$V_a = 25.6 + 2.92 \sin (x + 83°) + 0.28 \sin (2x + 168°) + 0.69 \sin (3x + 63°) + 0.21 \sin (4x + 78°)$$

where x is the time measured from the middle of January (one month = 30°) and the velocity V_a is given in miles per hour.

The variation shows the ordinary annual variation with a maximum just after the middle of January; a small semiannual variation with maxima near the solstices and minima near the equinoxes, and a remarkable variation with a period of four months, having maxima near the end of January, May, and September, and minima at the end of March, July, and November.

If we analyze the results given by von Herrmann for cyclones we get

$$V_c = 28.6 + 5.9 \sin (x + 91°) + 1.35 \sin (2x + 46°) + 0.47 \sin (3x + 266°) + 0.35 \sin (4x + 294°),$$

and the amplitudes diminish with the order of the component in a regular way: The second component is relatively larger than for anticyclones and has its maxima near the equinoxes and its minima near the solstices.

From the results for anticyclones in Europe, given by Brounow (Wild's Rep. für Met. Bd. X, 1887), we find

$$V_a = 17.3 + 0.72 \sin (x + 100°) + 0.71 \sin (2x + 176°) + 1.70 \sin (3x + 261°) + 1.26 \sin (4x + 238°).$$

From the results given by Hann for west Europe (Lehrbuch der Meteorologie, 1st ed., 1901, p. 502) we obtain for cyclones

$$V_c = 16.7 + 1.95 \sin (x + 115°) + 0.80 \sin (2x + 236°) + 0.77 \sin (3x + 282°) + 0.83 \sin (4x + 236°).$$

[a] Reprinted in the article next following.

The number of observations used by Brounow was considerably less than that used by von Herrmann and consequently the monthly variations are more irregular, but the third component is here also unusually large. It differs in phase by 198° from the corresponding variation in America, so that the conditions which accelerate anticyclones on one side of the Atlantic retard them on the other so far as this short period variation is concerned. Incidentally we remark that the fourth component shows a similar difference of phase.

For cyclones the variations have the same phase in Europe and America, except the half-yearly variation for which the phase difference is 190°.

If we take periods of five years from von Herrmann's results for anticyclones we get the following for the variation of velocity:

Period.

1889–1893. $V_a = 25.5 + 3.45 \sin(x + 73°) + 0.55 \sin(2x + 194°) + 0.76 \sin(3x + 158°) + 0.75 \sin(4x + 47°).$

1894–1898. $V_a = 23.8 + 2.77 \sin(x + 91°) + 0.39 \sin(2x + 198°) + 1.48 \sin(3x + 28°) + 0.57 \sin(4x + 62°).$

1899–1903. $V_a = 27.5 + 2.97 \sin(x + 100°) + 0.95 \sin(2x + 127°) + 1.18 \sin(3x + 18°) + 0.66 \sin(4x + 117°).$

Thus in every period the amplitude of the third component is unusually large so that we may conclude that the effect is real.

I have also arranged von Herrmann's results for anticyclones according to periods of fourteen months. By taking fourteen years, the harmonic variations having for their period 12, 6, 4, 3, 2 months, are eliminated. The analysis of the resulting values leads to the following expression for V_a, the first month of the whole period being January, 1889, and y being measured from the middle of this month:

$$V_a = V_0 + 0.27 \sin(y + 244°) + 0.39 \sin(2y + 292°) + 0.65 \sin(3y + 217°) + 0.80 \sin(4y + 300°).$$

The actual departures from the mean value, at the different epochs of the period are, in miles per hour:

Month	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Departure	−1.63	−0.60	1.23	−1.33	0.34	0.18	−1.12	0.0	1.13	0.14	0.75	−0.21	1.75	−0.62

For the half-period of seven months the departures are:

$$-0.81,\ +0.26,\ +0.68,\ -0.29,\ +0.06,\ +0.96,\ -0.86,$$

indicating a fairly well-marked period of three and one-half months.

It is not quite clear what the cause of this can be, but it may be associated with the change of latitude which has a period of fourteen months.

I have also arranged von Herrmann's results for cyclones for twenty-one years, 1882–1902, according to periods of fourteen months, but they show no marked periodic variation.

The departures for each month of the period from the mean value are as follows, the initial month being the same as for anticyclones:

Month........	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Departure.....	+0.4	−0.9	−0.3	−1.2	−0.8	+1.1	−0.2	+1.2	+0.6	−0.1	+0.2	+0.5	+0.2	−0.2

For the half period of seven months the departures are:

$$+0.8, \; -\; 0.15, \; -\; 0.2, \; -\; 0.5, \; -\; 0.15, \; +0.65, \; -\; 0.2,$$

in which the three and one-half-month period is not at all marked.

One can say, then, that the velocity of propagation of anticyclones has a marked period of about four months, but that of cyclones shows no such peculiarity.

THE VELOCITY OF THE CENTERS OF HIGH AND LOW PRESSURE IN THE UNITED STATES.

By C. F. von Herrmann, Section Director. Dated Baltimore, Md., May 9, 1907.

(Reprinted from the Monthly Weather Review, April 1907, pp. 169–171.)

The fact that the general motions of the atmosphere have a controlling influence upon the direction of motion and velocity of cyclones was recognized by Espy as early as 1841.[a] Ferrel, in 1859, suggested that the upper currents carry them along as a stream of water carries along the whirling eddies which we find in it.[b] We are indebted, however, to Loomis for the classical investigation of the velocity of storms in the United States.[c] Loomis found the average velocities from the weather maps for thirteen years, 1872 to 1884, and his results have been quoted quite generally in books on meteorology.[d]

The publication of Mr. Edward H. Bowie's new method of ascertaining the direction and velocity of single depressions gives new importance to the accurate determination of the mean rate of speed of storms as observed under different conditions in the past, and suggested the idea of recalculating the average velocities of highs and lows in the United States from the material supplied by the Monthly Weather Reviews. From 1878 to March, 1904, the latitude of origin and of disappearance, the length of path and velocity of high and low pressure areas have been published regularly, and the task of as-

[a] Espy: Philosophy of Storms, 1841.

[b] Motion of Fluids and Solids relative to the Earth's Surface, 1859, as mentioned in Ferrel's Treatise on Winds, 1889, p. 275.

[c] Contributions to Meteorology, Elias Loomis, 1886.

[d] The policy adopted by Gen. A. J. Myer was to confine the meteorological work of the Signal Service to observations and forecasts and the collection of data for the use of those professional meteorologists outside the Government service who were endeavoring to improve the science, properly so called. Therefore the Signal Service published little or nothing relating to theoretical meteorology during his administration, although numerous studies were in progress as unofficial work. With regard to the movements of areas of high and low pressure, reference may be made to the tables for 1872 and 1873, given at pages 154–159 of Part II of the Annual Report of the Chief Signal Officer, 1889, and especially to the tables by Professor Garriott contained in Bulletin A, "Summary of International Meteorological Observations," Washington, 1893.— Ed.

sembling the data for the entire period of twenty-six years was not a difficult one.

The results are given in Table 1, mean velocities and number of areas of low pressure in the United States, 1878–1904.

A comparison with the averages obtained by Loomis for the period 1872 to 1884 shows substantial agreement.

VELOCITY OF STORMS, LOOMIS, 1872-1884.

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
33.8	34.2	31.5	27.5	25.5	24.4	24.6	22.6	24.7	27.6	29.9	33.4	28.4

WEATHER BUREAU RECORDS, 1878-1904.

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
34.8	34.8	31.6	26.9	24.3	24.0	24.4	24.6	24.8	27.4	30.7	34.9	28.6

The average annual velocity from the Weather Bureau records is slightly higher than the earlier averages found. The only marked discrepancy occurs in August; the longer period does not show so marked a minimum velocity in that month as we find in Loomis's records. The minimum occurs in June. On the whole the mean velocities are very nearly equal during the three winter months, averaging about 35 miles an hour. There follows a brief transitional period when the velocity diminishes (March and April). During the five months from May to September, inclusive, the velocity does not vary widely from the mean of 24.4 miles. Again during October and November there is a transitional period with increasing velocities.

The general eastward motion of the atmosphere increases gradually upward from the earth's surface. Ferrel calculated that the eastward movement in the upper atmosphere is about 26 miles an hour at an elevation of 2.5 miles,[a] but Professor Bigelow, in his International Cloud Report, states that the maximum development of cyclones takes place at an elevation of from 3 to 4 miles, where the progressive motion of the air must be considerably greater, in fact agreeing closely with the speed of whirlwinds at the surface. The difference between the summer and winter velocities is quite marked; the ratio of the means during the two seasons is in round numbers 24 to 35, or nearly 1 to 1.5.

[a] Ferrel's Treatise on Winds, p. 277.

TABLE 1.—*Mean velocities and total number of centers of areas of*

[Velocity in

Year.	January.		February.		March.		April.		May.		June.	
	Velocity.	No.	Velocity.	No.	Velocity.	No.	Velocity.	No.	Velocity.	No.	Velocity.	No.
1878	26.3	11	28.9	8	24.3	10	15.3	6	16.9	7	15.7	6
1879	35.5	8	33.3	6	35.1	13	30.0	13	25.3	6	29.4	9
1880	30.4	14	39.6	14	35.7	14	27.2	9	25.1	7	24.5	8
1881	32.3	9	45.3	9	26.8	9	37.1	7	32.6	5	36.1	8
1882	42.6	13	43.2	11	34.8	10	29.5	11	21.6	4	26.8	7
1883	39.8	15	36.4	10	38.0	11	26.8	9	30.0	9	24.2	9
1884	42.5	17	47.4	15	33.3	13	20.7	9	26.8	10	19.1	6
1885	37.8	11	40.5	11	36.0	9	24.8	8	24.4	7	26.5	7
1886	36.7	10	32.2	13	31.0	14	19.7	6	24.8	11	23.8	10
1887	37.0	15	34.4	9	31.0	11	31.1	13	18.0	10	24.9	10
1888	39.4	10	33.2	9	34.5	9	35.9	9	26.8	10	24.6	12
1889	40.4	11	34.9	10	25.8	10	25.6	13	21.2	9	23.4	10
1890	40.0	12	37.0	15	37.0	12	37.0	10	31.0	12	18.0	9
1891	27.0	12	34.0	14	28.0	13	25.0	8	22.0	8	22.0	10
1892	32.0	13	34.0	9	29.0	13	30.0	8	28.0	11	28.0	11
1893	36.0	18	40.0	12	37.0	12	33.0	8	30.0	12	23.0	10
1894	33.0	16	35.3	15	31.0	16	20.3	14	20.0	10	19.0	17
1895	28.7	15	25.6	17	29.5	18	26.7	14	21.8	8	19.4	4
1896	25.7	9	29.6	14	27.9	10	23.6	9	21.1	10	24.1	8
1897	29.1	9	31.3	11	27.7	12	23.3	8	20.6	11	24.4	9
1898	36.6	12	27.2	8	29.1	10	25.3	7	19.4	9	24.3	10
1899	35.2	14	33.3	9	30.2	11	25.0	8	23.6	9	24.0	6
1900	37.0	14	37.3	15	35.6	14	23.1	13	30.3	9	22.1	9
1901	33.1	20	31.7	15	26.4	14	26.7	10	23.1	9	24.1	11
1902	33.7	11	31.5	7	29.7	10	27.8	11	28.2	9	27.7	10
1903	35.7	12	31.8	7	32.8	6	29.9	10	20.1	7	24.6	9
1904	36.0	13	31.5	13	34.8	9	......	......	......	......	......	....
Mean	34.8	12.8	34.8	11.3	31.6	11.6	26.9	9.7	24.3	8.7	24.0	9.0
Highest maximum velocities of individual lows	67.9	......	81.0	......	57.4	......	68.8	......	54.7	......	52.0	....
Means of all the monthly maximum velocities for 26 years (1878–1903)	51.4	......	52.8	......	45.6	......	40.2	......	35.2	......	34.3	....
Lowest minimum velocities of individual lows	4.2	......	8.3	......	6.5	......	8.0	......	7.0	......	7.0	....
Means of all the monthly minimum velocities for 26 years (1878–1903)	18.7	......	21.0	......	18.2	......	17.1	......	13.6	......	14.6	....

Total number of storms, 3,276.

low pressure in the United States for each month, 1878 to 1904.

miles per hour.]

July.		August.		September.		October.		November.		December.		Annual.		Year.
Velocity.	No.	Velocity.	No.	Velocity.	No.	Velocity.	No.	Velocity.	No.	Velocity.	No.	Velocity.	No.	
21.7	7	26.8	6	21.3	10	18.3	11	21.2	6	34.0	6	22.6	94	1878.
....	6	21.0	6	21.7	7	30.8	5	40.7	12	38.8	12	31.1	103	1879.
25.7	6	26.1	10	22.5	11	22.0	12	34.1	9	42.8	9	29.6	123	1880.
32.4	5	25.4	5	30.7	6	43.5	6	30.6	15	33.6	10	33.9	94	1881.
19.8	6	19.0	10	23.5	4	28.5	13	27.7	5	30.2	10	28.9	104	1882.
31.4	8	28.0	6	25.0	10	37.3	9	39.4	9	33.0	15	32.4	121	1883.
22.4	12	30.7	11	32.6	16	34.4	14	35.2	9	48.1	8	32.8	140	1884.
26.4	9	22.0	7	23.5	7	26.8	9	24.4	8	31.5	10	28.7	103	1885.
19.2	12	34.0	12	27.5	11	26.0	9	25.2	14	31.4	11	27.6	133	1886.
22.6	7	31.4	8	22.8	11	27.9	11	33.0	14	29.0	11	28.6	130	1887.
25.8	8	22.7	6	24.2	9	25.4	13	34.1	7	33.5	8	30.0	110	1888.
22.1	14	24.0	6	21.7	10	27.4	12	30.5	11	42.0	15	28.2	131	1889.
22.0	9	24.0	10	24.0	9	25.0	13	36.0	13	39.0	15	30.8	139	1890.
23.0	8	21.0	11	27.0	12	29.0	10	29.0	15	38.0	15	27.1	13[illegible]	1891.
30.0	11	25.0	8	26.0	10	27.0	10	31.0	16	35.0	11	29.6	131	1892.
26.0	7	19.9	9	21.2	11	25.0	15	30.3	15	36.1	14	29.8	143	1893.
17.0	11	19.6	16	20.0	11	19.0	15	27.4	17	28.6	17	24.2	178	1894.
21.6	11	22.3	17	24.3	9	25.9	15	34.2	10	31.3	14	25.9	152	1895.
23.6	11	27.6	10	25.1	11	24.4	9	33.8	8	31.8	12	26.5	121	1896.
19.5	8	22.0	9	25.5	10	26.7	12	27.7	8	32.4	12	25.8	119	1897.
27.3	6	21.2	8	22.6	8	24.5	8	27.8	14	28.4	9	26.1	109	1898.
20.9	7	16.7	9	27.9	10	25.3	10	25.9	10	36.5	16	27.0	119	1899.
29.2	12	26.0	9	24.5	11	26.0	17	27.8	17	34.8	16	29.5	156	1900.
22.1	7	28.2	6	25.9	8	28.4	14	28.6	16	36.2	11	27.9	141	1901.
31.1	7	28.5	8	26.6	11	28.7	8	28.2	11	32.9	9	29.6	110	1902.
27.0	7	25.8	7	26.1	7	29.5	9	35.5	12	39.3	11	29.8	104	1903.
......	....	......	....	......	....	......	....	......	....	......	....	......	....	1904.
24.4	8.6	24.6	8.8	24.8	9.6	27.4	11.1	30.7	11.6	34.9	11.8	28.6	125	Mean.
50.0	....	55.0	....	50.0	....	65.0	....	55.0	....	79.0	....	....	....	Highest maximum velocities of individual lows.
37.3	....	35.1	....	37.4	....	39.2	....	43.9	....	53.2	....	42.1	....	Means of all the monthly maximum velocities for 26 years (1878-1903).
8.0	....	4.2	....	4.0	....	4.0	....	4.3	....	6.3	....	....	....	Lowest minimum velocities of individual lows.
14.6	....	14.2	....	12.3	....	15.2	....	17.7	....	20.1	....	16.4	....	Means of all the monthly minimum velocities for 26 years (1878-1903).

TABLE 2.—*Mean velocities and total number of centers of areas of*

[Velocity in

Year.	January.		February.		March.		April.		May.		June.	
	Velocity.	No.	Velocity.	No.	Velocity.	No.	Velocity.	No.	Velocity.	No.	Velocity.	No.
1888	......	......	......	......	27.6	6	34.3	9	22.0	6	21.2	6
1889	17.6	7	24.8	7	27.7	8	21.5	8	18.1	7	22.0	6
1890	31.0	10	31.0	10	27.0	9	26.0	7	28.0	9	20.0	6
1891	29.0	9	30.0	6	28.0	10	26.0	8	23.0	7	19.0	6
1892	26.0	10	27.0	10	24.0	7	24.0	6	35.0	8	25.0	8
1893	30.0	14	34.0	12	29.0	9	34.0	12	31.0	7	23.0	5
1894	24.6	17	25.2	9	21.1	15	19.0	12	28.6	8	21.7	6
1895	39.4	11	25.5	12	26.7	11	22.1	10	21.8	6	24.9	4
1896	22.2	10	26.5	7	23.5	8	21.2	6	23.5	7	23.6	7
1897	27.3	6	26.1	8	25.7	6	24.0	11	19.4	7	23.7	7
1898	30.8	10	28.3	10	25.3	8	25.2	8	22.0	9	23.8	8
1899	30.8	10	27.1	6	22.7	8	19.4	6	24.9	6	22.0	7
1900	33.2	14	29.5	13	30.4	13	26.9	8	28.9	7	27.9	5
1901	33.5	10	28.8	9	26.6	7	28.7	6	22.0	4	25.5	4
1902	35.4	8	27.2	5	31.8	6	29.0	8	24.7	8	29.9	4
1903	36.0	8	27.8	8	29.4	9	21.9	10	32.6	4	26.2	4
1904	25.4	11	32.1	11	26.7	8	......	......	......	......	......	......
Mean	29.5	10.3	28.2	8.9	26.7	8.7	25.2	8.4	25.4	6.9	23.7	5.8
Highest maximum velocities of individual highs	66.7	......	50.0	......	50.0	......	50.8	......	58.0	......	57.7	....
Means of all the monthly maximum velocities of highs for 16 years	44.9	......	41.3	......	38.1	......	36.3	......	35.7	......	33.0	....
Lowest minimum velocities of individual highs	2.0	......	5.0	......	11.1	......	7.0	......	8.3	......	10.0	....
Means of all the monthly minimum velocities of highs for 16 years	16.2	......	15.2	......	17.0	......	16.0	......	15.5	......	17.6	....

Total number of highs, 1,587.

high pressure in the United States for each month, 1888 to 1904.

miles per hour.]

July.		August.		September.		October.		November.		December.		Annual.		Year.
Velocity.	No.	Velocity.	No.	Velocity.	No.	Velocity.	No.	Velocity.	No.	Velocity.	No.	Velocity.	No.	
19.7	8	25.8	5	21.1	8	25.4	10	25.7	6	18.3	6	......	...	1888.
17.0	7	16.5	6	22.9	9	20.7	10	26.0	7	35.0	12	22.5	94	1889.
22.0	5	26.0	9	24.0	8	23.0	11	30.0	7	32.0	9	26.8	100	1890.
23.0	5	26.0	7	28.0	6	23.0	10	24.0	8	28.0	12	25.6	90	1891.
24.0	4	24.0	7	25.0	10	24.0	11	31.0	10	28.0	8	26.4	99	1892.
27.0	5	13.5	4	22.8	7	21.0	10	23.2	6	28.2	15	26.4	100	1893.
15.7	5	13.8	9	21.2	12	27.2	12	29.9	17	26.9	15	22.9	137	1894.
19.5	11	18.8	14	21.6	9	25.6	11	21.0	4	20.2	3	23.9	100	1895.
22.2	7	22.5	6	24.7	7	21.9	10	27.6	5	24.8	8	23.7	88	1896.
20.6	4	25.2	8	21.7	9	24.7	10	25.8	7	22.9	7	23.9	88	1897.
22.1	6	21.4	6	24.3	6	23.8	8	25.5	9	24.5	7	24.8	93	1898.
20.4	6	24.3	6	23.5	9	23.3	6	25.2	9	30.5	9	24.5	88	1899.
23.9	9	22.0	6	25.3	10	27.0	8	29.8	11	27.3	14	27.7	118	1900.
25.1	6	25.1	9	29.0	4	29.7	11	25.7	14	31.1	12	27.6	96	1901.
29.0	5	23.8	6	32.8	9	25.8	8	32.6	10	20.9	10	29.3	87	1902.
23.2	9	24.6	6	27.7	7	29.0	8	30.9	6	31.6	10	28.4	89	1903.
......	...	......	...	......	...	......	...	......	...	......	...	......	...	1904.
22.2	6.4	22.1	7.1	24.7	8.1	24.7	9.0	27.1	8.5	27.4	9.8	25.6	99	Mean.
39.0	....	41.0	....	52.1	....	52.1	....	52.4	....	66.7	....	....	....	Highest maximum velocities of individual highs.
29.2	....	29.9	....	34.1	....	35.5	....	39.3	....	42.0	....	36.6	....	Means of all the monthly maximum velocities of highs for 16 years.
9.4	....	8.3	....	8.0	....	7.0	....	10.0	....	6.0	....	....	....	Lowest minimum velocities of individual highs.
15.8	....	15.1	....	14.9	....	15.7	....	17.1	....	14.9	....	15.9	....	Means of all the monthly minimum velocities of highs for 16 years.

The mean rate of progress of cyclone centers is much greater in the United States than over the Atlantic Ocean or in western Europe. The rates are: United States, 28.6 miles an hour; Atlantic Ocean, 18.1, and western Europe, 16.8 (Hann). The explanation is not difficult. In continental America the air contains far less moisture than it does over the Atlantic or over western Europe, and consequently the point of condensation where the maximum storm formation occurs must lie at a higher level over the broad continent. Over the oceans condensation begins at a much lower level, where the speed of the upper currents is far less, and the depressions can not be carried forward so rapidly. In winter on account of lower temperatures there is even less moisture in the air and so the region of maximum disturbance is elevated and the velocity of storms increased.

A velocity for individual depressions of 60 miles an hour or more has been observed in the United States fifteen times during the past twenty-six years. In some cases the velocity of the spirally inflowing winds must actually be less than the progressive movement of the disturbance as a whole. This was probably true on the following occasions when the mean velocity of the cyclone center exceeded 70 miles an hour:

December 26–28, 1880, 75 miles an hour; February 1, 1881, 75 miles an hour; February 8–9, 1884, 81 miles an hour; December 21–22 1884, 79 miles an hour; February 21, 1894, 75 miles an hour.

These are average velocities for the whole path of the storm, but the rate is never uniform, and no doubt at times the speed of these storms was even greater. Hann states that the maximum velocities known to him for Europe are—

December 16, 1869, and November 10–11, 1875, 70 miles an hour; March 12–13, 1876, at Hamburg, 76 miles an hour.

The average velocity of anticyclones is a matter of not less importance, but the values found are not so certain on account of the difficulty of fixing exactly the centers of high pressure areas. The data in the Monthly Weather Review enable us to calculate the mean rate of movement for the period of only sixteen years from 1888 to 1904. The results will be found in Table 2, mean velocities and number of anticyclones in the United States, 1888–1904. The annual mean is 25.6 miles an hour, which is only 10 per cent less than the speed of cyclones.[a] The maximum velocity is found in January, 29.5 miles, and the minimum in August, 22.1 miles. The maximum velocity of anticyclones rarely exceeds 60 miles an hour.

[a] The annual mean for the identical years 1889–1903 is for cyclones 27.2 and for anticyclones 25.6.

CHANGES OF ATMOSPHERIC DENSITY IN STORMS.

By J. I. Craig, M. A., F. R. S. E., F. R. Met. S. Dated Survey Department, Giza, Egypt, May 17, 1909.[a]

Of all the causes of rainfall the most important is now generally conceded by meteorologists to be the mechanical decrease of temperature which takes place when a mass of air expands without gain of heat. Such an expansion is nearly always due to decrease of pressure, which may be caused in two ways, either by the air moving from a lower to a higher level, or by horizontal movement from a locality of high barometer to one of lower. It may happen that both causes are at work, in which case conditions are most favorable to expansion. It is the object of the present paper to show that such is the case locally in cyclonic and V-shaped depressions, and that the expansion as measured at the surface exhibits some correspondence with the rainfall.

If we confine our attention to a mass of air m, small enough to be considered as of uniform density, ρ, then

$$\Omega\rho = m \text{......} (1)$$

where Ω is the volume. If the mass of air be supposed to have the form of a cylinder of base A and altitude h, then

$$\Omega = Ah$$
$$\text{and } Ah\rho = m$$

Taking logarithms and differentiating with respect to the time we get[b]

$$\frac{1}{A}\frac{dA}{dt}+\frac{1}{h}\frac{dh}{dt}+\frac{1}{\rho}\frac{d\rho}{dt}=\frac{1}{m}\frac{dm}{dt}$$

[a] This paper was communicated to the British Association last September, but has only been printed in summary in the British Association Report. I have kept it back from publication in the hopes that I should be able to develop more fully a point that I noticed after sending it to the secretary of the association, that in many cases the ascending current in front of the depression is lighter than the descending current in rear. There is thus on the whole a fall of matter, and this may in large part account for the maintenance of the energy of the storm. I have attached a short postscript to the paper. At the time I was under the impression that the idea of the light and dense currents was new, but I have since found that Professor Bigelow had already developed it. This note may therefore be considered as additional evidence in favor of his theory.—J. I. C.

[b] We use d for total differential and ∂ for partial differential.—Editor.

where we must take account of the movement of the air in differentiating. It is always possible that, from rainfall or absorption of evaporated water the mass of the air considered is not constant, so that $\frac{dm}{dt}$ is not zero, but for the present it is proposed to consider only the case where m is constant, so that $\frac{dm}{dt}=o$. This being so

$$\frac{1}{h}\frac{dh}{dt}=-\left[\frac{1}{A}\frac{dA}{dt}+\frac{1}{\rho}\frac{d\rho}{dt}\right]$$

and h will increase, or there will be upward movement of the air as a whole if the bracket is negative. It will be shown later that in front of the trough of a circular or a V-shaped storm ρ is decreasing with the time, and Doctor Shaw and Mr. Lempfert have shown that A is also decreasing in the same localities, whence it follows that there must be upward movement of the air column as a whole, whereas in the rear of the trough both A and ρ are on the whole increasing, so that here there must be descent of the air.

Returning to equation (1) and differentiating after taking logarithms, we have

$$\frac{1}{\Omega}\frac{d\Omega}{dt}+\frac{1}{\rho}\frac{d\rho}{dt}=0$$

on the assumption that the mass of air under consideration is unaltered. But the first term is the dilatation. Hence in calculating the dilatation $\triangle$ we may use the formula

$$\triangle=-\frac{1}{\rho}\frac{d\rho}{dt}$$

It is to be noticed that as we are dealing with one and the same mass of air the differentiation must take account of the movement of that mass; we must differentiate along the path. This fact leads to the consideration of masses of air whose paths are known, and we therefore naturally turn for material to the work of Doctor Shaw and Mr. Lempfert on this subject.[a]

By a method fully explained in their paper, the authors have investigated the paths followed by certain masses of air moving along the surface of the earth. They give tables exhibiting the temperature, pressure, and velocity of the different air masses considered, usually at intervals of two hours. These tables are generally complete as far as the pressure and wind velocity are concerned, but somewhat less full in the details of the temperature. The humidity is not given,

[a] The Life History of Surface Air Currents, by W. N. Shaw, Sc. D., F. R. S., and R. G. K. Lempfert, M. A. (London, Wyman & Sons, 1906.)

owing to the uncertainty of any method of deriving this datum by interpolation.

With the materials thus provided, the density of the air for each of the epochs given in the tables was computed. The dilatation is expressible when the rate of change of the density at any time is known, which might have been determined by drawing curves to exhibit the relation between the density and the time. For the purpose of this investigation, however, it is sufficient to take the finite difference for each period of two hours and assume that this is the value of the differential coefficient for the middle of the interval. The densities were computed in milligrammes per liter and the unit of time is two hours. The dilatation is $-\frac{1}{\rho}\frac{d\rho}{dt}$; hence to derive its absolute value the change of density should be divided by the mean density in the interval, and the sign reversed. In what follows the actual change of density only has been employed and it must, therefore, be remembered that a negative change of density means dilatation of the air while a positive change of density means negative dilatation or condensation, and also that the absolute values may be found with sufficient accuracy by dividing the changes of density by 1 250, which is about the mean density of the air considered. The error so introduced will be much less than that already existing from unavoidable errors of observation.

It seemed probable that any dilatation phenomenon would turn out to be related to the position of the center of the storm (where there is a center) and to the trough. Accordingly, the plates in Shaw and Lempfert, where the movement of the air had been referred to the center, were utilized, and the changes of density were inserted at points midway between the relative positions of the air mass at each two-hourly interval. When this had been done, it was seen that

(1) On the whole the front of the trough is a region of negative change of density and therefore of dilatation of the surface air:

(2) On the whole the rear of the trough is a region of positive change of density and therefore of negative dilatation, or condensation, of the air.

Of the four storms considered, three (see figs. 1, 3, and 4) show dilatation in front of the trough, and contraction in rear, while one (fig. 2) shows dilatation in every quadrant, but to a much less degree in rear than in front. It has been pointed out by Doctor Shaw and Mr. Lempfert that this storm of November 11–13, 1901, in many other respects formed a complete contrast to the other two circular storms mentioned (figs. 3 and 4); it is now seen that surface dilatation forms still another point of contrast.

It is to be remembered that the values of the dilatation here found are those at the surface only, and that they do not give the means

for verticals through different points of the storm, but that the rainfall probably depends on these means. It is not to be expected, therefore, that we shall find complete agreement between the rainfall and the numerical values found above, and in point of fact such complete agreement does not exist. For, as has been shown by Dr. H. R. Mill in a paper read before this association in 1904, the region of heaviest rainfall lies to the *left* of the path of the storm and this is found to be the case in the three circular storms under consideration. On the other hand figures 1, 3, and 4 show that the surface dilatation is greatest, on the whole, to the *right front* of the storm and we might accordingly expect the heaviest precipitation to be in this part. It has been suggested by Doctor Shaw and Mr. Lempfert that the rain is actually formed in greatest abundance in the southeast quadrant of the storm, is then carried northward by the ascending air and ultimately falls considerably farther to the north, in the northeast quadrant of the storm. If, however, this mechanical transport of the raindrops is alone in operation, to shift the zone of maximum rainfall to the north of the storm track, we must suppose that in some cases the rain is carried northwards a distance of at least 70 or 80 miles from the zone of formation of raindrops, by a current of air whose total velocity (not all northwards) is only some 40 to 50 miles an hour. The time during which the raindrops are suspended in the air, necessitated on this hypothesis, approaches and may exceed two hours, which seems somewhat excessive. Another explanation may, however, be put forward, in no way precluding the former, but rather supplemented by it, so that the causes evoked are both at work. The process of dilatation may and probably does continue for a longer time in the ascending air than it does at ground level, or, what comes to much the same thing, the ascending air, being freed from surface friction, may acquire a greater velocity, and so advance farther to the northward in a given time than the surface air. Either cause would tend to throw the region of greatest mean condensation farther to the northward, when the facts of dilatation and precipitation would be reconciled. A somewhat similar explanation may probably obtain for the protrusion of the region of rainfall in rear of the trough.

Returning now to the figures illustrating the distribution of dilatation, we may note that, although the region hehind the trough is one of condensation on the whole, there are evidences of regions of dilatation. Some of these are doubtless due to observational errors, but the fact that in many cases the negative change of density is reproduced by several trajectories that pass near the region, seems to prove that the phenomenon is real. If it is, it may be put forward as an explanation of the "passing showers" that characterize the rear half of a depression.

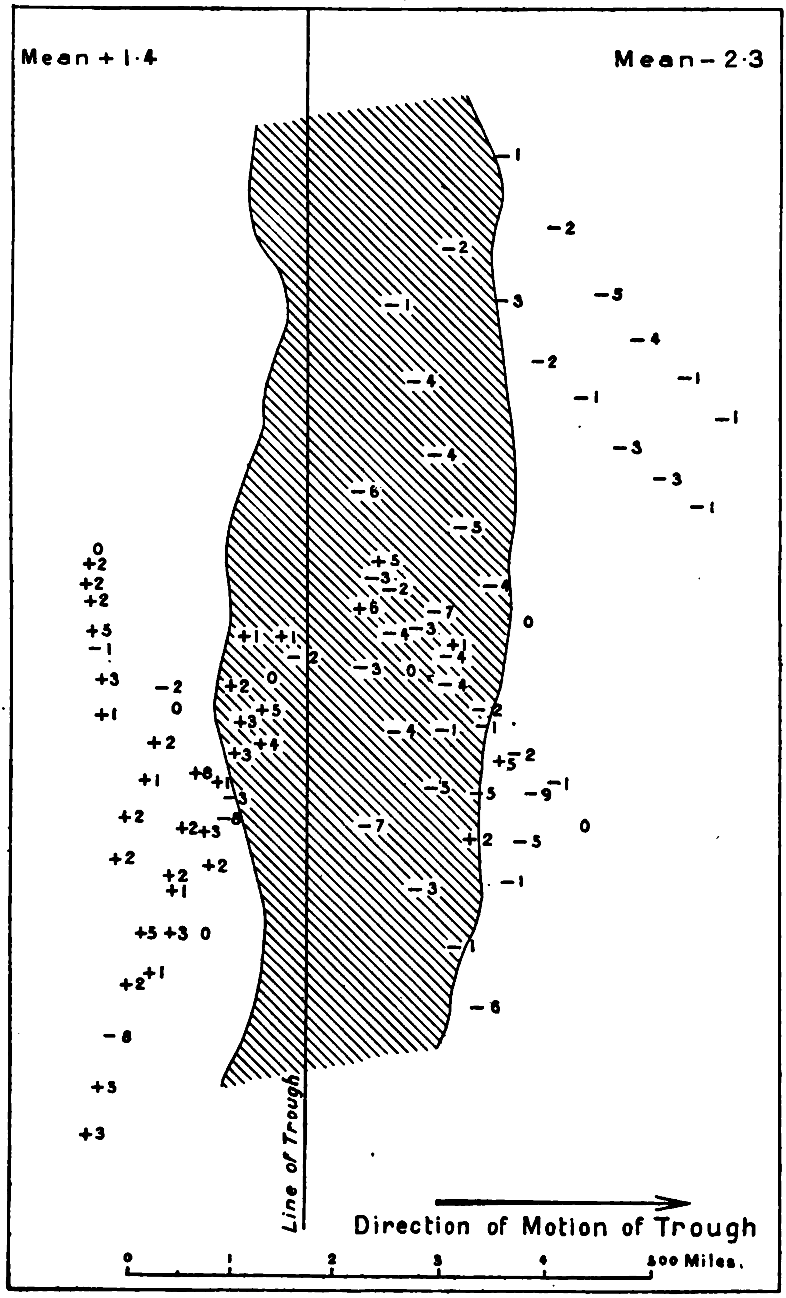


FIG. 1.—V-shaped depression January 5–7, 1900.

The shaded portion shows the region in which rain fell.

Doctor Shaw and Mr. Lempfert have discussed the ascent or descent of the air by considering the contraction or expansion of the figure bounded by a filament of air particles. In some cases the figure has been rectilineal, in others, circular. It has been shown above that, theoretically, change of density should be considered along with the change of area, but in practice the rate of change of density is so small compared with [the rate of change] of the base area that the latter becomes the dominant factor in the determination of ascent or descent. Still though the changes of density are numerically of a much lower order than the changes of area, it is significant to note that in no case are the indications of the one contradictory to the other. There is thus some ground for assuming that changes of density, which are more easily calculated than the other, may be accepted as showing whether the air is ascending or descending and not simply dilating or contracting.

Theoretically this question may be approached in the following way. The equation of continuity for an elastic fluid is

$$\frac{\partial\rho}{\partial t}+\frac{\partial(\rho u)}{\partial x}+\frac{\partial(\rho v)}{\partial y}+\frac{\partial(\rho w)}{\partial z}=0$$

which may be written in the equivalent form

$$\frac{\partial\rho}{\partial t}+u\frac{\partial\rho}{\partial x}+v\frac{\partial\rho}{\partial y}+w\frac{\partial\rho}{\partial z}+\rho\left(\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}+\frac{\partial w}{\partial z}\right)=0$$

or

$$\frac{1}{\rho}\,\frac{d\rho}{dt}+\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}+\frac{\partial w}{\partial z}=0.$$

In this equation the first term may be calculated by following the change of density as the air moves along a trajectory; the second may be computed by drawing a synoptic chart of eastward velocity of the air, and then computing graphically the eastward rate of change of this component velocity; and the third may be computed in a similar way. Thus the numerical value of the fourth term $\frac{\partial w}{\partial z}$ may be found, and we may employ Maclaurin's theorem to find the vertical velocity of the air at points not too distant from the ground. For, by using the suffix $_0$ for values at ground level, we have $w_0=0$, since there is no vertical velocity actually at the surface of the ground,

$$\frac{\partial w_0}{\partial z}=+a$$

where $-a$ is the value just found for

$$\frac{1}{\rho}\,\frac{d\rho}{dt}+\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}$$

Thus $w=az+Bz^2+$higher terms.

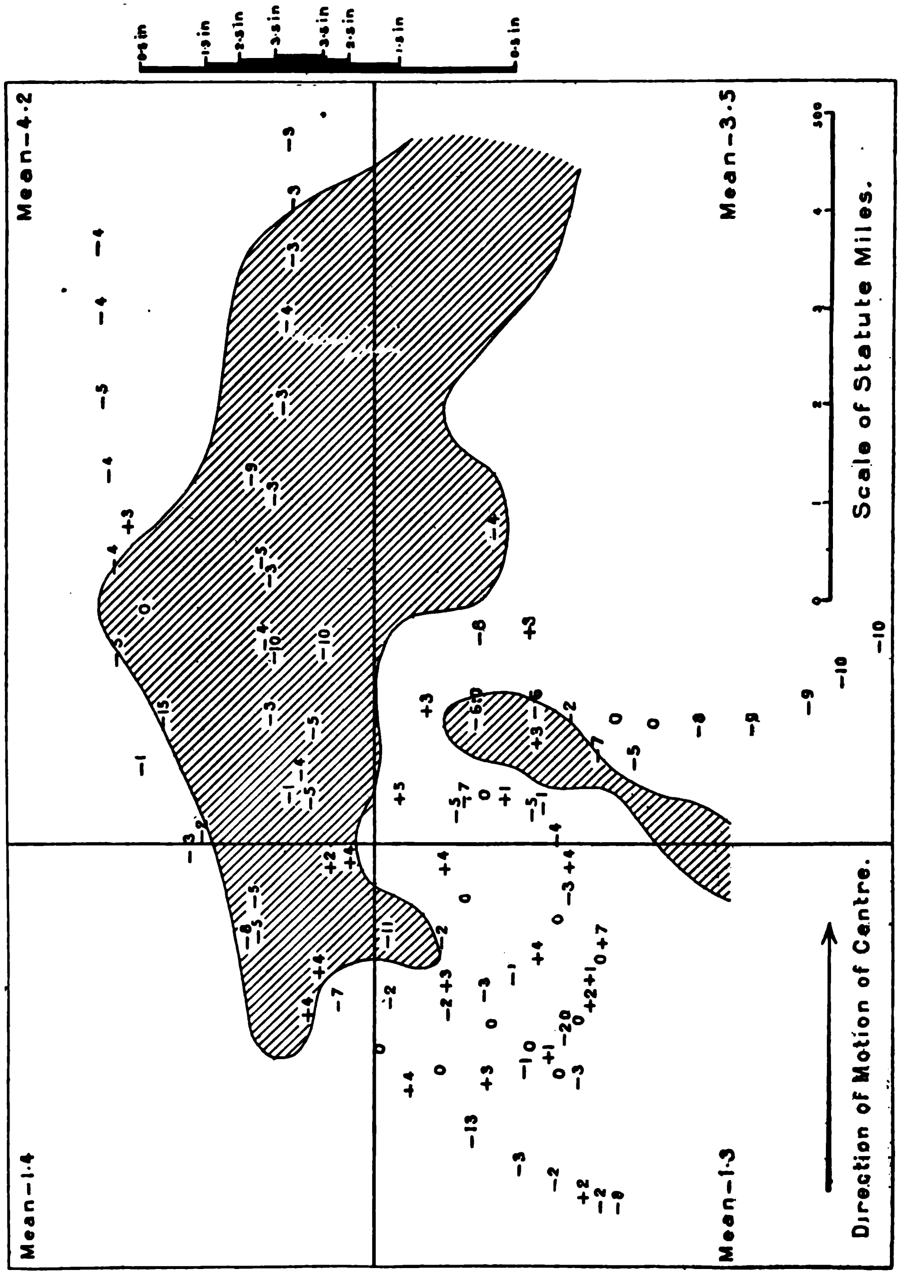


FIG. 2.—Slow traveling depression of November 11-13, 1901.
The shaded portion shows the region in which rain fell.

Distribution of rainfall on either side of the path.

This relation will hold, of course, only to heights such that the terms after the first are negligible in comparison with the first.

Failing the application of this theory to a practical case, we may apply it to an ideal storm, where the isobars are assumed, for simplicity, to be circles, and the winds blow round the isobars with uniform velocity and uniform incurvature.

In this case

$$u = V \sin (\theta - a)$$
$$v = - V \cos (\theta - a)$$

where θ is the azimuth of the point seen from the center. Then since u and v are functions of θ alone and not of r, we have

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = - \frac{V}{r} \sin a$$

where r is the distance from the center.

Hence

$$\frac{1}{\rho} \frac{d\rho}{dt} - \frac{V}{r} \sin \alpha + \frac{\partial w}{\partial z} = 0.$$

If the change of density per unit of time is so small that we may neglect it, then

$$\frac{\partial w}{\partial z} = \frac{V}{r} \sin \alpha$$

and so the first term in the expansion of w is $\frac{Vz}{r} \sin a$.

To get an estimate of the magnitude of this term, let us consider a storm where

$V = 50$ kilometers per hour
and $r = 100$ kilometers.
Then $w = 0.5\, z \sin a$.
If $a = 30°$ and z is 0.1 of a kilometer, then, $w = 0.025$,

or the updraft would be only 25 meters per hour. At 10 kilometers from the center the updraft would be 250 meters an hour, and so on.

Incidentally it may be noted that in this case, if the winds are tangential to the isobars, so that $a = 0$, then the existence of an updraft or downcast will depend entirely on the sign of $\frac{1}{\rho} \frac{d\rho}{dt}$. For then

$$\frac{1}{\rho} \frac{d\rho}{dt} + \frac{\partial w}{} = 0.$$

If $\frac{d\rho}{dt}$ is negative, there will be updraft, if positive, downdraft; and since in the neighborhood of Britain the winds are generally found to

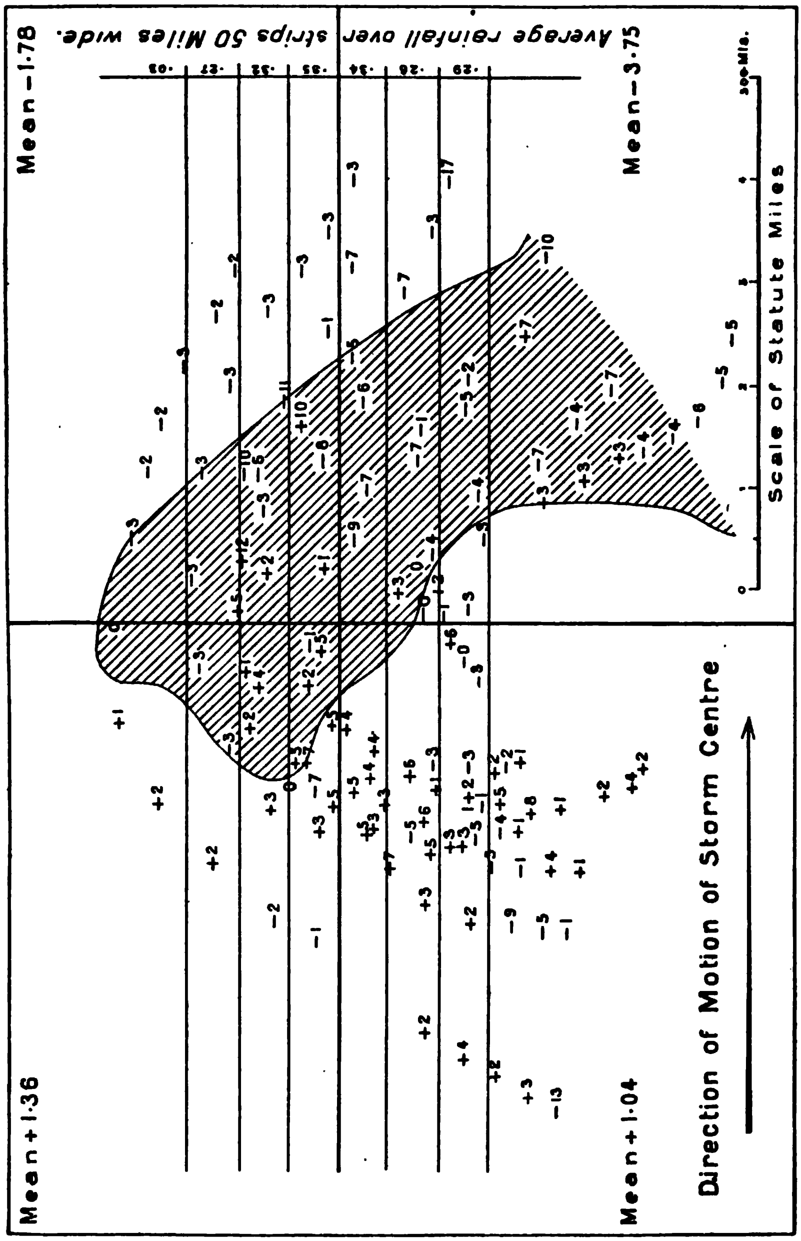


FIG. 8.—Circular storm of March 24–25, 1902.
The shaded portion shows the region in which rain fell.

blow nearly tangentially to the isobars, it may be concluded that the quantity $-\frac{1}{\rho}\frac{d\rho}{dt}$ gives here a measure of the updraft.

I have to express my thanks to Doctor Shaw for his helpful interest in this paper, and to Capt. H. G. Lyons, F. R. S., Director General of the Survey Department, Egypt,[a] not only for permission to publish, but for more active encouragement in the matter of research generally, which has made this work possible.

POSTSCRIPT.

Since the above was written, I have noticed that in the case of some at least of the trajectories worked out by Doctor Shaw and Mr. Lempfert, the ascending currents in front of the storm are rarer than the descending currents in rear. There is thus distinct evidence that the motion of the storms in which this happens is accompanied by the fall of gravitating matter on the whole, and in this we may find the explanation of the maintenance of the kinetic energy of the storm in spite of the resistance caused by "friction." Doctor Shaw draws an analogy between the movement of the air in a storm and that of the bulb of an ideal conical pendulum where there is constant kinetic energy and no change of potential energy. In nature, however, the pendulum would slowly come to rest owing to friction, unless the work done against friction were compensated by the loss of potential energy in some other body. To pursue the analogy, the weight of the clock is now equivalent to the excess of mass of the denser falling air over the lighter rising air.

At the time I noticed this fact I was under the impression that it was new, but since then I see that Professor Bigelow has developed the same idea into a complete theory of cyclonic storms.[b] This note may therefore be regarded as additional evidence in support of his theory.

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[a] Now professor of geography, University of Glasgow.—EDITOR.

[b] See also the writings of Dr. Julius Hann and Dr. Max Margules.—EDITOR.

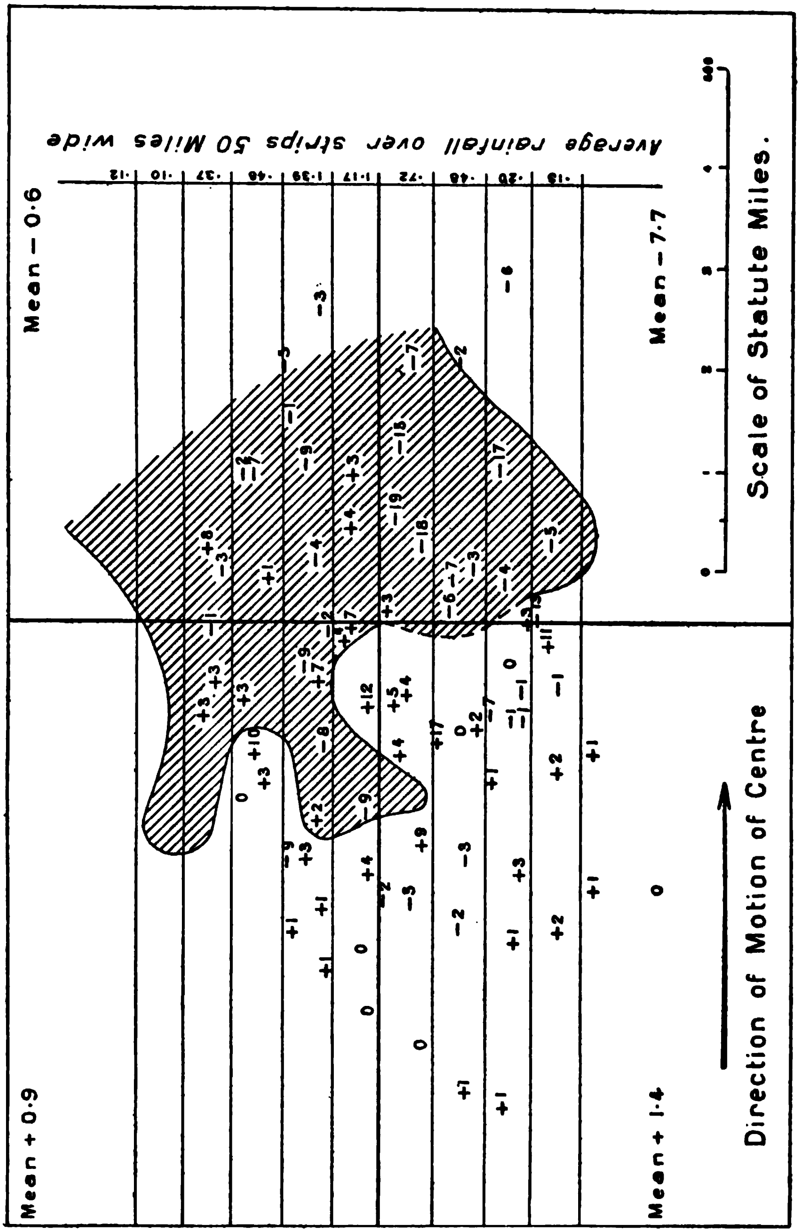

FIG. 4.—Circular storm of September 10-11, 1908.
The shaded portion shows the region in which rain fell.

PYRHELIOMETER AND POLARIMETER OBSERVATIONS.

By H. H. Kimball.

FURTHER STUDY OF THE RELATION BETWEEN SKY POLARIZATION AND ATMOSPHERIC TRANSMISSIBILITY.

In this Bulletin, volume 1, pages 207–231, and volume 2, pages 55–65, may be found a résumé of the results of measurements of the intensity of solar radiation and of the percentage of polarization of sky light at Washington and Mount Weather up to June 30, 1908. In this present paper are given the results for the year ending June 30, 1909, including some pyrheliometer readings made by the writer at Hopkinton, N. H., elevation about 400 feet, while on a vacation in August, 1908.

COMPARISON OF PYRHELIOMETERS.

Table 1 shows the results of the intercomparison of different Ångström pyrheliometers, and also comparisons between Ångström pyrheliometers and Smithsonian pyrheliometer No. VIII. This latter was kindly loaned to the Weather Bureau by the director of the Astrophysical Observatory of the Smithsonian Institution, and through his courteous cooperation simultaneous readings were made with it and Smithsonian pyrheliometer No. V on May 28, 1908, and January 28, 1909. The results on both days gave the factor 0.917, by which to reduce the scale readings of No. VIII to heat units on the Smithsonian scale.

The ratios in Table 1 for August 2 and 9 and September 2, 1909, were obtained by means of simultaneous readings on Smithsonian pyrheliometer No. VIII by the writer and on Ångström pyrheliometers by Mr. W. R. Gregg. All other comparisons have been made by one observer, and the ratio determined by the method explained on page 89, volume 1.

TABLE 1.—*Comparison of pyrheliometers.*

Date.	Ratios.											
	S. VIII / 104	S. VIII / 105	S. VIII / 28_{bis}	S. VIII / 31	S. VIII / 122	104 / 28_{bis}	105 / 28_{bis}	122 / 28_{bis}	31 / 28_{bis}	105 / 31	104 / 105	122 / 104
1908.												
Apr. 4									1.029			
11									1.024			
13						1.072						
16									1.017			
21									1.034			
May 26									1.021			
June 1						1.070						
2	*1.128*		1.202	1.173					1.023			
July 11										1.003		
16		*1.165*	1.208							1.011		
Aug. 2			1.213									
Sept. 8			1.238			1.083						
9			1.168									
16			1.188			1.076						
29			1.227			1.088						
Oct. 2			1.245									
3			1.225									
Nov. 12						1.079						
13		*1.164*					1.062				*1.060*	
1909.												
Feb. 6			1.196									
Mar. 23	1.106		1.218			1.102						
Apr. 24	1.110		1.216			1.092						
26			1.238									
28			1.222									
July 8			1.248									
Aug. 2		1.169	1.235				1.056					
9		1.168	1.204				1.034					
30			1.245				1.064					
Sept. 2		1.173									*1.053*	
25	1.136		1.264			1.113						
Oct. 19								1.104				
22	*1.113*				1.107			1.095				1.005
25								1.110				

NOTE.—S. VIII denotes Smithsonian pyrheliometer No. VIII. The numbers 28_{bis}, 31, 104, 105, and 122 denote Ångström pyrheliometers, the previous history of which will be found on page 86 of volume 1. Figures in italics indicate that the ratio has been obtained indirectly, and not through direct comparative readings between the two instruments.

A comparison of the ratios in Table 1 with those given in Table 6, page 92, volume 1, indicates that Ångström No. 104, which has been preserved as a standard, has undergone practically no change since its receipt by the Weather Bureau in December, 1907, while No. 28_{bis} and No. 105, which have been in constant use at Washington and at Mount Weather, respectively, read about 6 per cent lower than at that time, but only slightly lower than on July 16, 1908. The factors used during the past year to reduce the readings of these two instruments to the scale of Ångström pyrheliometer No. 104 or to the Smithsonian pyrheliometric scale[a] have been determined by taking the mean

[a] In the Astrophysical Journal, volume 29, page 288, Abbot has shown that the new provisional standard scale of the Smithsonian Institution is only 2.6 per cent higher than the scale of Ångström pyrheliometer No. 104. In order that the computations of the solar constant here given may be comparable with those heretofore published, the "arbitrary multiple pyrheliometer scale" described in Annals of the Astrophysical Observatory, volume 2, page 47, is still adhered to as the Smithsonian pyrheliometric scale.

of all the ratios obtained between June 2, 1908, and the date of the observations to be reduced.

In August, 1908, Ångström pyrheliometer No. 31 was accidentally injured to such an extent as to render it unserviceable. No. 122 was received from Ångström in October, 1909.

OBSERVATIONS.

Table 2 gives the intensity of solar radiation as measured by the Ångström pyrheliometer at Washington (including the Hopkinton observations), reduced to the scale of Ångström No. 104, and Table 3 gives the same readings reduced to the Smithsonian pyrheliometric scale and to mean solar distance. Tables 4 and 5 contain similar data for Mount Weather.

In Table 6 is given the percentage of polarization of skylight at Washington, measured at the point of maximum, i. e., 90° from the sun but in his vertical, by means of a Pickering polarimeter, with the sun at different angular distances from the zenith. The column headed a_x shows the diurnal variation in polarization, which follows very closely the law [a]

$$a_x^m = \frac{P_m}{P_1}$$

where m represents the secant of the sun's zenith distance, P_m the corresponding polarization, and P_1 the polarization with the sun in the zenith. In general, the polarization increases with increasing zenith distance of the sun, but when the atmospheric conditions are unsteady the accidental variations in polarization may exceed the diurnal, sometimes causing the polarization to decrease with an increase in the sun's zenith distance, and again causing it to fluctuate irregularly.

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[a] See vol. 2, p. 60.

TABLE 2.—*Washington pyrheliometer observations reduced to the scale of Ångström No. 104, expressed in gram-calories per minute per square centimeter of normal surface.*

Date.	Air mass.								
	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0
1908.									
July 6, a. m.									1.245
11, a. m.					0.882	0.917	1.060	1.070	1.115
11, p. m.					0.534	0.654	0.800	0.982	
16, a. m.					0.975	1.067	1.168	1.263	1.410
Aug. 2, a. m.					0.814	0.929	1.059	1.209	
2, p. m.					0.719	0.830	0.958	1.072	1.271
3, a. m.								0.938	1.071
4, a. m.								1.002	1.118
4, p. m.								1.043	
20, a. m.[a]					1.097	1.168	1.243	1.323	
21, a. m.[a]					0.996	1.073	1.155	1.252	1.363
21, p. m.[a]					0.866	0.960	1.065	1.181	
29, p. m.[a]					1.031	1.121	1.219	1.326	1.442
Sept. 8, p. m.						0.909	1.016	1.138	1.275
9, p. m.						0.826	0.948	1.090	1.253
16, a. m.					1.001	1.081	1.169	1.263	1.367
29, a. m.					0.881	0.997	1.124	1.270	
29, p. m.				0.873	0.961	1.049	1.093	1.243	
30, a. m.					0.642	0.751	0.878		
30, p. m.				0.650	0.741	0.846	0.966	1.076	
Oct. 2, a. m.					0.861	0.994	1.147		
2, p. m.				0.877	0.967	1.067	1.177	1.298	
3, a. m.					1.020	1.106	1.199	1.298	
3, p. m.			0.934	0.980	1.061	1.130	1.215	1.307	
4, p. m.			0.890	0.958	1.031	1.110	1.196	1.223	
5, a. m.					0.671	0.775	0.894	1.032	
5, p. m.				0.627	0.716	0.817	0.934	1.066	
6, p. m.		0.704	0.773	0.848	0.932	1.024	1.126	1.110	
12, a. m.					0.947	1.045	1.155	1.292	
12, p. m.		0.904	0.965	1.024	1.102	1.186	1.276	1.373	
13, a. m.					0.703	0.826	0.971	1.143	
31, a. m.				0.902	0.990	1.087	1.194	1.311	
Nov. 5, a. m.				0.824	0.896	0.957	1.064		
12, a. m.					1.123	1.200	1.283		
12, p. m.		0.694	0.766	0.844	0.930	1.027	1.132		
17, a. m.						1.113	1.198		
18, p. m.			0.519	0.601	0.697	0.856	0.983		
27, a. m.						1.198	1.266		
Dec. 2, p. m.	0.671	0.727	0.788	0.854	0.927	1.006	1.091		
8, p. m.			0.849	0.955	1.034	1.103	1.168		
23, p. m.		0.988	1.041	1.096	1.167	1.251	1.341		
1909.									
Jan. 26, p. m.						0.969	1.181		
Feb. 1, p. m.					0.870	1.195	1.303		
6, p. m.				0.885	0.981	1.068	1.152		
8, p. m.							1.042		
11, p. m.		0.910	0.958	1.056	1.127	1.202	1.282		
17, p. m.			0.899	0.931	1.015	1.107	1.207	1.316	
Mar. 5, p. m.				0.910	0.992	1.079	1.176	1.280	
18, p. m.					0.850	0.973	1.019	1.157	
20, p. m.						0.870	0.990	1.126	
23, p. m.			0.774	0.855	0.944	1.044	1.153	1.275	
Apr. 24, p. m.							0.840	0.954	1.326
26, p. m.					0.833	0.950	1.063	1.232	1.355
28, a. m.					1.008	1.098	1.201	1.315	1.439
May 4, a. m.					0.946	1.040	1.143	1.250	1.341
4, p. m.							1.001	1.116	
12, a. m.							1.164	1.255	1.354
12, p. m.							1.115	1.224	
17, a. m.						0.890	1.009	1.144	
June 18, p. m.					0.901	0.995	1.099	1.214	1.284

[a] Observations at Hopkinton, N. H.

TABLE 3.—*Washington pyrheliometer observations reduced to the Smithsonian pyrheliometric scale and to mean solar distance, expressed in gram-calories per minute per square centimeter of normal surface.*

Date.	Air mass.								
	5.0.	4.5.	4.0.	3.5.	3.0.	2.5.	2.0.	1.5.	1.0.
1908.									
July 6, a. m									1.430
11, a. m					1.013	1.053	1.217	1.229	1.280
11, p. m					0.613	0.751	0.919	1.127	
16, a. m					1.119	1.225	1.341	1.449	1.618
Aug. 2, a. m					0.931	1.062	1.211	1.382	
2, p. m					0.822	0.949	1.095	1.226	1.453
3, a. m								1.073	1.223
4, a. m								1.145	1.278
4, p. m								1.192	
20, a. m.[a]					1.247	1.328	1.413	1.505	
21, a. m.[a]					1.105	1.203	1.308	1.423	1.549
21, p. m.[a]					0.984	1.091	1.210	1.342	
29, p. m.[a]					1.168	1.270	1.381	1.502	1.633
Sept. 8, p. m						1.024	1.145	1.282	1.436
9, p. m						0.930	1.068	1.227	1.411
16, a. m					1.123	1.213	1.311	1.417	1.534
29, a. m					0.982	1.108	1.252	1.414	
29, p. m				0.972	1.070	1.168	1.218	1.384	
30, a. m					0.715	0.836	0.977		
30, p. m				0.723	0.825	0.942	1.075	1.198	
Oct. 2, a. m					0.957	1.105	1.276		
2, p. m				0.975	1.075	1.186	1.309	1.442	
3, a. m					1.134	1.229	1.332	1.443	
3, p. m			1.038	1.089	1.167	1.255	1.350	1.452	
4, p. m			0.989	1.064	1.146	1.233	1.327	1.358	
5, a. m					0.745	0.860	0.992	1.145	
5, p. m				0.696	0.795	0.907	1.037	1.184	
6, p. m		0.781	0.858	0.941	1.034	1.137	1.248	1.232	
12, a. m					1.047	1.156	1.276	1.429	
12, p. m		1.000	1.067	1.132	1.218	1.311	1.411	1.518	
13, a. m					0.776	0.912	1.073	1.262	
31, a. m				0.987	1.083	1.190	1.306	1.434	
Nov. 5, a. m				0.898	0.977	1.043	1.160		
12, a. m					1.222	1.305	1.395		
12, p. m		0.755	0.847	0.919	1.012	1.117	1.231		
17, a. m						1.208	1.291		
18, p. m			0.563	0.652	0.756	0.929	1.066		
27, a. m						1.299	1.373		
Dec. 2, p. m	0.726	0.785	0.850	0.922	1.000	1.084	1.175		
8, p. m			0.915	1.029	1.114	1.188	1.261		
23, p. m		1.062	1.119	1.178	1.254	1.345	1.441		
1909.									
Jan. 26, p. m						1.044	1.272		
Feb. 1, p. m					1.181	1.289	1.405		
6, p. m				0.956	1.060	1.176	1.303		
8, p. m							1.121		
[illegible] m		0.985	1.037	1.144	1.220	1.301	1.388		
17, p. m			0.976	1.010	1.102	1.202	1.310	1.431	
Mar. 5, p. m				0.995	1.084	1.180	1.286	1.399	
18, p. m					0.936	1.073	1.123	1.274	
20, p. m						0.959	1.074	1.242	
23, p. m			0.854	0.944	1.043	1.153	1.274	1.408	
Apr. 24, p. m							0.945	1.073	1.491
26, p. m					0.938	1.069	1.219	1.387	1.526
28, a. m					1.131	1.237	1.354	1.482	1.621
May 4, a. m					1.070	1.175	1.292	1.413	1.516
4, p. m							1.142	1.261	
12, a. m							1.321	1.424	1.536
12, p. m							1.265	1.389	
17, a. m						1.013	1.148	1.303	
June 18, p. m					1.033	1.141	1.2[illegible]	1.393	1.473

[a] Observations at Hopkinton, N. H.

TABLE 4.—*Mount Weather pyrheliometer observations reduced to the scale of Ångström No. 104, expressed in gram-calories per minute per square centimeter of normal surface.*

Date.	Air mass.								
	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0
1908.									
July 11, a. m.				0.618	0.650	0.716	0.830	0.998	1.220
16, a. m.			0.943	1.003	1.065	1.142	1.222	1.315	1.419
Aug. 4, a. m.			0.754	0.819	0.892	0.980	1.074	1.179	1:295
4, p. m.								1.125	
30, a. m.					0.926	1.001	1.083	1.169	
31, a. m.					0.798	0.885	0.981	1.089	1.222
31, p. m.			0.627	0.676	0.703	0.807	0.928	1.067	1.226
Sept. 2, p. m.							1.050	1.245	
3, p. m.					0.920	1.009	1.107	1.218	1.330
9, a. m.					1.020	1.094	1.174	1.287	1.425
9, p. m.				0 957	1.024	1.101	1.194	1.295	1.403
16, a. m.				1.002	1.054	1.159	1.225	1.294	
16, p. m.			0.838	0.924	0.929	1.020	1.119	1.227	
29, a. m.			0 952	1.014	1.080	1.150	1.210	1.297	
Oct. 2, a. m.			0.811		0.923				
3, a. m.		1.006	1.044	1.093	1.151	1.213	1.279	1.355	
3, p. m.		0.950	1.002	1.061	1.126	1.196	1.271	1.349	
Nov. 13, p. m.						1.212	1.315		
17, a. m.			0.998	1.060	1.127	1.197	1.271		
21, a. m.	0.980	1.017	1.057	1.096	1.159	1.175	1.167		
Dec. 2, p. m.	0.862	0.908	0 956	1.017	1.088	1.163	1.244		
8, a. m.	0.929	0.975	1.022	1.078	1.146	1.170	1.237		
8, p. m.	0.822	0.877	0.935	0.998	1.064	1.135	1.211		
1909.									
Apr. 24, a. m.						1.066	1.153	1.211	1.230
26, p. m.					0.921	1.019	1.126	1.245	1.377
May 12, a. m.						1.146	1.242	1.346	
17, a. m.					0.963	1.053	1.153		

TABLE 5.—*Mount Weather pyrheliometer observations reduced to the Smithsonian pyrheliometric scale and to mean solar distance, expressed in gram-calories per minute per square centimeter of normal surface.*

Date.	Air mass.								
	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0
1908.									
July 11, a. m.				0.710	0.746	0.822	0.953	1.146	1.401
16, a. m.			1.083	1.151	1.223	1.311	1.402	1.509	1.629
Aug. 4, a. m.			0.860	0.935	1.018	1.117	1.225	1.345	1.477
4, p. m.								1.286	
30, a. m.					1.048	1.133	1.226	1.323	
31, a. m.					0.903	1.001	1.110	1.232	1.382
31, p. m.			0.709	0.764	0.795	0.913	1.050	1.207	1.387
Sept. 2, p. m.							1.186	1.406	
3, p. m.					1.040	1.140	1.250	1.371	1.503
9, a. m.					1.149	1.232	1.322	1.449	1.604
9, p. m.				1.078	1.154	1.240	1.345	1.457	
16, a. m.				1.125	1.183	1.300	1.375	1.452	
16, p. m.			0.941	1.036	1.042	1.144	1.256	1.377	
29, a. m.			1.060	1.129	1.203	1.281	1.348	1.445	
Oct. 2, a. m.			0.902		1.032				
3, a. m.		1.118	1.160	1.215	1.279	1.346	1.421	1.506	
3, p. m.		1.056	1.114	1.179	1.251	1.329	1.412	1.499	
Nov. 13, p. m.						1.317	1.430		
17, a. m.			1.083	1.151	1.223	1.299	1.379		
21, a. m.	1.061	1.102	1.145	1.188	1.255	1.273	1.264		
Dec. 2, p. m.	0.930	0.980	1.032	1 098	1.174	1.255			
8, a. m.	1.001	1.051	1.101	1.161	1.234	1.313	1.333		
8, p. m.	0.886	0.945	1.008	1.075	1.147	1.223			
1909.									
Apr. 24, a. m.						1.199	1.296	1.362	1.384
26, p. m.					1.037	1.147	1.268	1.402	1.550
May 12, a. m.						1.300	1.409	1.527	
17, a. m.					1.095	1.198	1.311		

TABLE 6.—*Maximum polarization of skylight at Washington.*

Date.	Secant of sun's zenith distance.					e_s	Remarks.
	1.0	2.0	3.0	4.0	5.0		
1908.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*		
July 11, a. m.	52.4	57.6	61.2			1.080	Polarization diminishing at variable rate.
11, p. m.		54.2				0.972	
16, a. m.	68.3	66.6	66.1			0.997	
Aug. 2, a. m.		60.6					Polarization irregular.
2, p. m.	56.1	57.2	58.3			1.019	
3, a. m.	46.0						
4, a. m.	48.8						
4, p. m.		52.3					
Sept. 8, p. m.		58.2					Do.
9, p. m.	55.7	58.0				1.042	
16, a. m.	60.7	63.1				1.040	
29, a. m.		62.5					Polarization increasing.
29, p. m.		61.8	65.0			1.051	
30, a. m.		54.7					Polarization increasing at variable rate.
30, p. m.		59.9	61.3				
Oct. 2, a. m.		59.4					Polarization increasing.
2, p. m.		64.9	62.3	59.9		0.972	
3, a. m.		64.9				1.010	Polarization irregular.
3, p. m.		66.8	68.1	69.3		1.019	
4, p. m.		66.5	68.6	69.1			
5, a. m.		52.1	54.1			1.038	
5, p. m.		50.9	53.3			1.048	
6, p. m.		54.0	59.1				
12, a. m.		55.0					Do.
12, p. m.		66.5	67.4	69.8		1.012	
13, a. m.		53.6				0.980	
31, a. m.		62.0	63.9				
Nov. 5, a. m.		56.2	58.9			1.052	
12, a. m.		67.2	70.0			1.043	
12, p. m.		63.2	63.8	64.1	64.5	1.007	
17, a. m.		59.4					Snow on ground.
18, p. m.		42.7	50.6	53.2		1.055	Do.
27, a. m.		68.8					Polarization irregular.
Dec. 2, p. m.		60.7	62.0	63.3	64.0	1.021	
8, p. m.		63.5	66.2	65.6			
23, p. m.		49.3	56.6	59.1	61.8		Snow on ground.
1909.							
Jan. 26, p. m.		63.8					Polarization decreasing.
Feb. 1, p. m.		67.5	68.1			1.008	
6, p. m.		62.5	61.9	61.2		0.990	
8, p. m.		51.1					Snow on ground.
11, p. m.		64.8	65.4	66.0		1.009	
17, p. m.		63.1	64.8	65.5			
Mar. 5, p. m.		51.4	55.9			1.087	Do.
18, p. m.	56.6		59.7				Polarization irregular.
20, p. m.		52.0				1.047	
23, p. m.		61.2	61.3				
Apr. 24, p. m.		52.2					Do.
26, p. m.	59.9	59.0	58.9			0.993	
28, a. m.		62.2	61.3			0.965	
May 4, a. m.	61.7	62.0	62.3			1.005	
4, p. m.		57.0					Do.
12, a. m.	59.7	60.8				1.023	
12, p. m.		59.2					Do.
17, a. m.		57.0					
June 18, p. m.	57.7	63.4	63.8				
Mean.						1.018	

TABLE 7.—*Solar constant computations from Washington observations.*

Date.	Q_3/Q_2.	e_0.	δ.	δ'.	a_x.	Q_0(W.B.).	Q'_0.	Q_0 (Fowle.)	Relative weight.
1908.									
July 11, p. m.	0.667	10.97	1.430	....	0.972	1.989	....	2.318	3
16, a. m.	0.834	10.59	0.345	0.500	0.997	2.010	2.143	2.165	3
Aug. 2, a. m.	0.786	12.24	0.555	0.687	....	2.005	2.110	2.304	3
2, p. m.	0.751	10.08	0.870	0.825	1.019	1.981	1.952	2.182	2
Sept. 8, p. m.	0.799	8.48	0.630	0.783	(+)	1.886	1.988	2.016	1
9, p. m.	0.758	10.21	0.810	0.791	1.042	1.900	1.887	2.093	1
16, a. m.	0.855	7.57	0.320	0.599	1.040	1.897	2.118	2.016	2
29, a. m.	0.784	5.56	0.875	0.618	(−)	2.174	1.997	2.287	1
29, p. m.	....	5.16	....	0.642	1.051	....	1.955	....	1
Oct. 2, a. m.	....	5.79	....	0.733	(−)	....	2.120	....	1
2, p. m.	0.821	4.14	0.670	0.542	0.972	2.094	2.011	2.178	4
3, a. m.	0.851	6.76	0.370	0.542	1.010	1.960	2.094	2.061	2
3, p. m.	0.865	5.41	0.325	0.499	1.019	1.923	2.061	2.028	1
4, p. m.	....	6.76	....	0.500	(+)	....	2.054	2.001	1
5, a. m.	....	7.87	....	1.076	1.038	....	1.872	....	1
5, p. m.	....	8.43	....	1.143	1.048	....	2.010	....	1
6, p. m.	0.829	7.29	0.485	....	(+)	1.929	....	2.038	1
12, a. m.	0.821	4.75	0.640	....	....	2.088	....	2.124	4
12, p. m.	0.863	3.63	0.385	0.500	1.012	2.083	2.125	2.124	8
13, a. m.	0.723	5.79	1.370	0.997	0.980	2.150	1.933	2.301	1
31, a. m.	0.829	3.45	0.625	0.635	(+)	2.050	2.060	2.129	3
Nov. 5, a. m.	0.809	1.78	0.870	0.871	1.052	1.940	1.946	1.991	1
12, a. m.	0.876	2.74	0.340	0.480	1.043	1.950	2.070	2.040	2
12, p. m.	0.821	2.24	0.750	0.595	1.007	1.992	1.894	2.040	4
18, p. m.	0.761	4.22	1.160	....	....	1.985	....	2.082	2
27, a. m.	....	4.57	....	0.443	(+)	....	2.043	....	1
Dec. 8, p. m.	....	2.03	....	0.585	(+)	....	1.928	....	1
23, p. m.	0.870	3.10	0.370	....	....	2.056	....	2.143	3
1909.									
Jan. 26, p. m.	....	1.80	....	0.575	....	....	1.936	....	1
Feb. 1, p. m.	....	1.04	....	0.473	1.008	....	2.054	....	1
6, p. m.	0.873	3.18	0.760	0.618	0.990	2.136	2.036	2.213	2
11, p. m.	0.879	1.38	0.360	0.544	1.009	1.947	2.084	2.021	2
17, p. m.	0.841	1.69	0.620	0.595	(+)	2.022	2.008	2.088	3
Mar. 5, p. m.	0.843	2.16	0.575	....	....	1.968	....	2.032	5
18, p. m.	0.776	2.26	1.150	....	(+)	2.045	....	2.097	1
20, p. m.	....	3.99	....	1.081	1.047	....	1.949	2.049	1
23, p. m.	0.819	2.37	0.755	0.663	(+)	2.068	2.009	2.139	2
Apr. 26, p. m.	0.769	4.37	1.070	0.783	0.993	2.212	2.032	2.311	3
28, a. m.	0.835	3.00	0.600	0.628	0.985	2.102	2.122	2.184	6
May 4, a. m.	0.828	4.75	0.580	0.635	1.005	2.022	2.062	2.088	4
4, p. m.	....	3.30	....	0.834	(−)	....	1.916	....	1
12, a. m.	0.859	3.81	0.425	0.679	1.023	1.940	2.120	2.010	2
12, p. m.	....	3.99	....	0.743	....	....	2.077	....	1
17, a. m.	....	7.29	....	0.821	....	....	1.993	....	1
June 18, p. m.	0.820	4.75	0.645	0.588	(+)	2.018	1.976	2.113	3
Means					1.015	2.013	2.020	2.118	....
Means from a. m. observations					1.017	2.018	2.050	2.132	....
Means from p. m. observations					1.013	2.009	1.997	2.110	....

NOTE.—Relative weight applies solely to the character of the plotted pyrheliometer observations, 10 being given to observations extending throughout both a. m. and p. m. that plot on practically the same line. In the column headed a_x, (+) and (−) indicate that while the readings of the polarimeter were too irregular to admit of a determination of the value of a_x, they did show that its value was above or below the average, respectively.

TABLE 8.—*Solar constant computations from Mount Weather observations.*

Date.	Q_3/Q_2.	e_w.	δ	Q_0(W.B.).	Q_0 (Fowle.)	Relative weight.
1908.						
July 16, a. m.	0.872	9.31	0.215	1.945	2.049	3
Aug. 31, p. m.	0.758	11.49	0.785	1.868	2.038	1
Sept. 3, p. m.	0.813	8.81	0.534	1.990	2.031	2
9, p. m.	0.858	10.00	0.257	1.919	2.034	1
16, p. m.	0.830	6.81	0.505	1.942	2.052	1
Oct. 3, p. m.	0.886	5.26	0.235	1.929	2.021	3
1909.						
Apr. 26, p. m.	0.818	3.91	0.705	2.048	2.131	4
May 17, a. m.	0.836	6.68	0.475	2.002	2.112	2
Mean	....	....	....	1.972	2.067	....

SOLAR CONSTANT COMPUTATIONS.

In Table 7 are given the results of computations of the value of the solar constant from Washington observations by methods[a] explained in volume 1, pages 207–231, and volume 2, pages 60–62. Table 8 contains corresponding values computed from Mount Weather observations, except that the polarization of skylight has not been considered in the determination of the latter values.

At Washington observations were obtained on a greater number of days during the year ending June 30, 1909, than during the previous year; and as compared with the observations of this latter year they indicate an increase in the percentage of polarization of skylight and in the measured intensity of solar radiation. The mean computed value of the solar constant does not differ materially from that heretofore obtained.

While the mean values of $Q_{0(W.B.)}$ and Q'_0 are practically in accord, daily values differ by as much as 10 per cent. Variations in atmospheric transmissibility during the period of observation, and inaccurate determinations of the vapor content of the atmosphere are no doubt causes of errors in the computed values of $Q_{0(W.B.)}$; while the latter cause, coupled with an imperfect knowledge of the relation between the polarization and δ will introduce errors in the computed values of Q'_0.

The values of e_0 given in Table 7, column 3, were determined at the time when the sun's zenith distance was 60° ($m=2$). In summer at Washington this occurs at about 8 a. m. and 4 p. m., apparent solar time. At this season of the year e_0 passes through a maximum value at about 8 a. m. and through a minimum value at about 4 p. m., the departures from the normal amounting to about +1 mm. and −1 mm., respectively. At higher levels in the atmosphere the vapor pressure varies with the temperature, the maximum occurring in the afternoon and the minimum in the morning.[b]

From Tables 4 and 5, page 217, volume 1, it can be seen that with a given ratio of Q_3/Q_2 an increase of 20 per cent in the value of e_0 will diminish the computed value of $Q_{0(W.B.)}$ by about 1 per cent, while with a given value of δ an increase of 1 mm. in the value of e_0 will increase the computed value of Q'_0 by about 1 per cent. One would therefore expect that the diurnal variation in the value of e_0 would cause the values of Q'_0 computed from a. m. obser-

[a] Abbot (loc. cit.) has shown that the curve of intensity of solar radiation outside the earth's atmosphere employed in these computations is probably in error, especially for the violet end of the spectrum, and that this error would materially affect the absolute value of computed solar constant values, but not the variation in values from day to day.

[b] Hann, Lehrbuch der Meteorologie, Zweite Auflage, pp. 175–176.

vations to be considerably higher than the average, and the corresponding values of $Q_{0(W.B.)}$ to be only slightly lower than the average. Table 7 shows that this is true with respect to the values of Q'_0, but that the a. m. and p. m. determinations of the value of $Q_{0(W.B.)}$ are practically in accord.

In the results obtained prior to June 30, 1908, the a. m. values of $Q_{0(W.B.)}$ are about 0.3 per cent lower than the average, the corresponding values of Q'_0 being about 1 per cent higher than the average, as in Table 7. Apparently, therefore, while an appreciable error is introduced into the values of Q'_0 by inaccurate determination of the water vapor content of the atmosphere, the corresponding error in the values of $Q_{0(W.B.)}$ is unimportant.

In order to eliminate as far as possible errors due to variations in atmospheric transmissibility during the period of observation, the values of $Q_{0\,(W.B.)}$ having a relative weight greater than 1, on days when the value of a_x did not depart by more than 2 per cent from its average value, have been printed in bold-face type. The highest of the seventeen values thus selected is 2.068, and the lowest 1.940, with a mean of 2.005, and extreme departures from the mean of only 3 per cent.

At Mount Weather fewer observations were obtained during the current year than the preceding, and on only eight days were they of a character to admit of their being used in solar constant computations. On most days there was evidence of diminished atmospheric transmissibility at noon as compared with the morning and late afternoon, the cause of which is now being investigated. It seems probable that it is associated with the haze which is almost always present in the atmosphere in greater or less quantities over this portion of the Blue Ridge Mountains. Not much weight can therefore be given the values of the solar constant shown in Table 8. It is to be noted that the mean values given in Table 7 are in close agreement with the means given on page 220, volume 1, and page 63, volume 2.

CONCLUSIONS.

At sea level no great accuracy can be expected in solar constant computations based on vapor pressure and pyrheliometric observations alone, on account of the changes in atmospheric transmissibility that are liable to occur during the time required to obtain a series of pyrheliometric observations. Similarly, no great accuracy can be expected in solar constant computations based on vapor pressure, polarization, and pyrheliometric observations taken simultaneously, on account of the probability of an erroneous determination of the vapor content of the atmosphere; but from a series of pyrheliometric

and polarization observations extending over a period sufficiently long to determine accurately the ratio $\frac{Q_2}{Q_1}$ and the factor a_x, coupled with a determination of the value of e_0, the error in the computed values of the solar constant due to the above-mentioned causes should not be greater than 3 per cent, provided we only make use of observations obtained on days when the readings of both the polarimeter and the pyrheliometer indicate steady atmospheric conditions.

MOUNT WEATHER, VA., *October 26, 1909.*

RECENT BUILDING OPERATIONS AT MOUNT WEATHER, VA.

By Alfred J. Henry.

Building operations at Mount Weather, Va., were resumed on July 1, 1908. Four projects were undertaken, viz: (1) The completion of the cottage and office building; (2) the completion of the physical laboratory building; (3) the erection of a central heating and power plant; and (4) the erection of a main observatory building to replace the building destroyed by fire in October, 1907.

(1) The cottage and office building was under roof and ready for plastering when further work on it was suspended about January 1, 1907. On July 6, 1908, work was resumed and rapidly pushed to completion, the building being occupied as living quarters about September 23, 1908. This building was originally intended for use as an office and living quarters for one of the research directors, hence its name "cottage and office building." It is now used as the living quarters of the commissioned staff at Mount Weather. A view of it is shown on the left in Plate 2.

(2) The physical laboratory building was barely under roof when work on it was suspended, near the end of 1906. The unfinished portion was completed in March, 1909, at a cost of a little more than $10,000. Considerable work, however, in the way of constructing laboratory tables and supports, remained to be done at that date. Since then the workshops have been partially equipped and some headway has been made in supplying the laboratory with standard apparatus. Most of the latter had to be imported. A view of the physical laboratory and the cottage and office building is shown in Plate 2.

(3) Work on a building for a central heating and power plant was begun in July, 1908, and the building was completed by day labor in a little less than four months. It is of stone and concrete construction, 62 feet long and 34 feet wide. Steam is provided by two 45-horsepower boilers and power is furnished by a 25-kilowatt generator directly connected to a 45-horsepower steam engine. A storage battery

of 120 cells, capable of delivering current at 220 volts, is operated in connection with the power plant. The battery furnishes sufficient power to operate the kite reel and the machine shops and provide current for electric lighting when the central power plant is not running. The cost of the plant was approximately $15,000. A view of it is seen in Plate 3.

(4) The main observatory building was well under way on June 30, 1909. It is expected that it will be completed about January 1, 1910.

THE CONSTRUCTION OF A WEATHER BUREAU KITE.[a]

By Alfred J. Henry.

This paper has been prepared primarily to answer inquiries that are made from time to time respecting the construction of Weather Bureau kites. The kites now used are essentially of the same type and construction as those known as the Hargrave-Marvin pattern, devised by Prof. C. F. Marvin and used in the Weather Bureau kite campaign at 17 stations during 1897. The only important modifications that have been introduced since that date are in the dimensions, experience having shown that a smaller and stronger size of kite is required for high winds, while for light winds a greater spread of sustaining or lifting surface is necessary. Three sizes of kites are in use at the Mount Weather Research Observatory. They may be classed as High Wind Kites, Moderate Wind Kites, and Light Wind Kites. The details of construction for the different sizes are precisely the same. As will be understood from the description and detail drawings which follow, this form of construction has certain advantages and disadvantages. One of the chief disadvantages is its frailty. Collision with the ground or other object is almost invariably followed by a bad smash of the kite; likewise when the sails become water-logged the shrinkage of the cloth is frequently powerful enough to crush the framework of the kite. On the other hand the broken sticks are easily and quickly replaced and the kite itself is conveniently collapsed for shipment. This is a very important point at Mount Weather, since in the course of a year a large number of kites have to be returned from the surrounding country.

As is well known, the kite consists of two cells joined together by longitudinal strips of straight-grained spruce. The front cell has a middle plane in it, and in this respect it differs from the Hargrave pattern. The details which follow refer to what is known at

[a] I am indebted to Prof. C. F. Marvin, of the Weather Bureau, and Research Director W. R. Blair, of this observatory, for valuable suggestions in connection with this paper, and especially to Mr. Frank H. Jackson, architect, who made the original drawings and conducted the experiments.

Mount Weather as the "moderate-wind kite," for winds of 12 to 30 miles per hour (5.4 to 13.4 meters per second). Its extreme dimensions are as follows:

	Ft.	in.	Cm.
Length or distance fore and aft	6	8½	=204
Width or distance from side to side	6	5½	=197
Depth or distance from top to bottom of cell	2	8½	= 83

The area of sustaining or lifting surface is 68 square feet (6.3 square meters), and of steering surface 22.8 square feet (2.1 square meters). It weighs about 8½ pounds (3.8 kilos).

For light winds (8 to 10 miles an hour or 3.6 to 4.5 m. p. s.) a kite having 120 square feet of sustaining or lifting surface is occasionally used; and for high winds (30 to 40 miles an hour or 13 to 18 m. p. s.) a third size is used. The latter is described in the Bulletin of the Mount Weather Observatory, Vol. I, page 99.[a]

The material required in the construction of the moderate wind kite includes:

(A) Forty-one sticks of the following dimensions:

1, ⅜ inch × ½ inch × 7 feet 5 inches.	Center bridle stick; square edges.
5, ⅜ inch × ⅜ inch × 6 feet 7 inches.	Corners and back center; square edges.
8, ⅜ inch × ¼ inch × 6 feet 7 inches.	Horizontal front and back edges of cells; rounded edges.
12, ⅜ inch × ⅜ inch × 2 feet 1 inch.	Horizontal sides, tapering to ⅜ inch × ¼ inch at ends.
8, ⅜ inch × ¼ inch × 2 feet 1 inch.	Horizontal intermediates, bracing horizontal sides; rounded edges.
4, ⅜ inch × ¼ inch × 3 feet 2$\frac{5}{16}$ inches, for horizontal center; rounded edges.	
3, ⅜ inch × ¼ inch × 2 feet ¼ inch.	Vertical center; rounded edges.

(B) The sticks are made of straight-grained spruce. All horizontal sticks should have their edges rounded, so that the end resistance of the kites to the wind will be less. Thirteen yards of Lonsdale cambric 26½ inches wide; some coarse waxed linen thread for lashing angles to sticks; 175 feet of fine piano wire, diameter 0.028 inch, for bracing.

(C) Forty-eight metal angles as shown by detail sketch, figure 6, are used to fasten the principal joints, 1 to 24, figure 4; thirty metal angles as shown by detail sketch, figure 7, for all intermediate joints, excepting at *N*, *P*, *Y*, and *W*, which are simply lashed with waxed thread. The isometric detail, figure 6, shows how these joints are fastened. These metal angles are made especially for the Weather Bureau. They are not on the market.

Figure 1 is an elevation of the front or bridle face of the kite, i. e., the lower surface when flying. The opposite face, i. e., the upper surface or rear surface of the kite, is the same except as to the size

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[a] A Kite for Use in High Winds. W. R. Blair, Bulletin of the Mount Weather Observatory, Vol. I, part 2, p. 99; see also Vol. I, part 1, p. 12, for illustrations of kites used at Mount Weather.

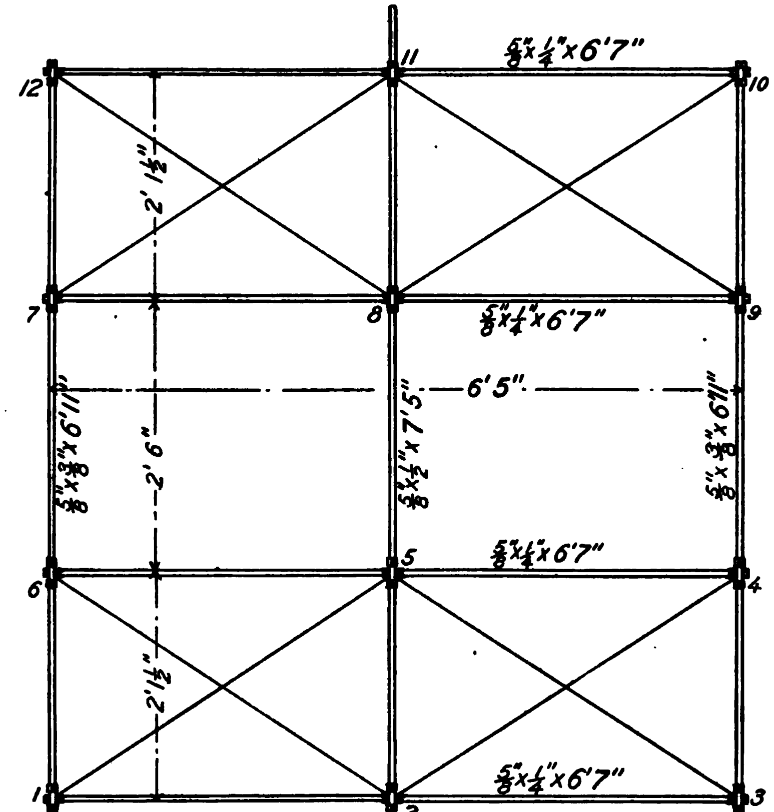

Fig. 1.
front

Kite Sticks, Clamps &c.

1	5/8"x1/2"x7'5" square edges.	48 Metal clamps – Fig. 6.
5.	5/8"x3/8"x6'11" " "	30 " " " 7.
8.	5/8"x1/4"x6'7" rounded edges.	175 ft. No. piano wire
12.	5/8"x3/8"x2'1" tapering to 5/8"x1/4" at ends.	13 yds. Lonsdale Cambric
8.	3/8"x1/4"x2'1" rounded edges.	26½" wide.
4.	3/8"x1/4"x3'2 3/16" " "	
3.	3/8"x1/4"x2' 1/4" " "	

and length of the bridle stick. Figure 2 is a sectional elevation showing the central or bridle truss, and figure 3 is an elevation of one of the two side trusses. The fine diagonal lines in figures 1, 2, 3, and 4 show the system of wire bracing necessary to preserve the form and rigidity of the framework. This bracing is all done with very fine piano wire secured to the metal angles as shown in figure 6 for the vertical cross bracing; in the horizontal and the long vertical bracing the wire is looped over the small bolthead in the metal angles before the bolt is tightened up. All metal angles are lashed to the sticks with well waxed linen thread.

After the frame is put together and securely braced, care being taken that all angles are true and square, the kite is ready for the sails. These are made from white Lonsdale cambric[a] 2 feet 2½ inches wide and 7 feet 2 inches long, being hemmed ½ inch on each edge and each end. A strong cord should be passed through this hem to lessen the danger of tearing. The sails are stretched around the kite frame and lashed to the horizontal and vertical sticks with waxed thread.

A middle sail is placed in the center of the top section extending from *MV* to *QZ* (see fig. 4). This sail should be exactly 2 feet 1½ inches wide and 6 feet 5 inches long after being hemmed as described for the main sails, and should be lashed to the sticks in a similar manner.

The method of attaching the kite to the line wire is shown in the isometric detail, figure 5. A stout cord about 18 inches long is fastened to the bridle stick at point 11, to this is attached a cloth-bound elastic bridle, looped and fastened as shown. To the end of this bridle is attached another stout cord, double looped about 18 inches long, with a strong brass ring at the end. This cord extends as shown, and is fastened to the extreme front end of the bridle stick From this point a wire brace extends back and is fastened at point 14, as seen in figure 2. The elastic cord used in making bridles is manufactured especially for the Weather Bureau. It consists of thin strips of rubber about one-quarter of an inch wide tightly bound in a cloth cover, in the form of a small rope about five-eighth inch in diameter. On account of the elasticity of the rubber this arrangement protects the kite and wire from sudden gusts of wind by allowing the kite to take a smaller angle, thus diminishing the pull.

The head kite, which carries the meteorograph, has its brass ring fastened directly to the line. Secondary kites are attached to the line by means of cords about 125 feet long. These cords are attached to the line in the following manner: A piece of No. 12 soft iron

[a] The rear cell and sometimes both cells are covered with a black fabric known to the trade as "mercerized" silk. It has the property of shedding water to a much greater extent than cambric. For that reason kites covered with it are preferred during fog.

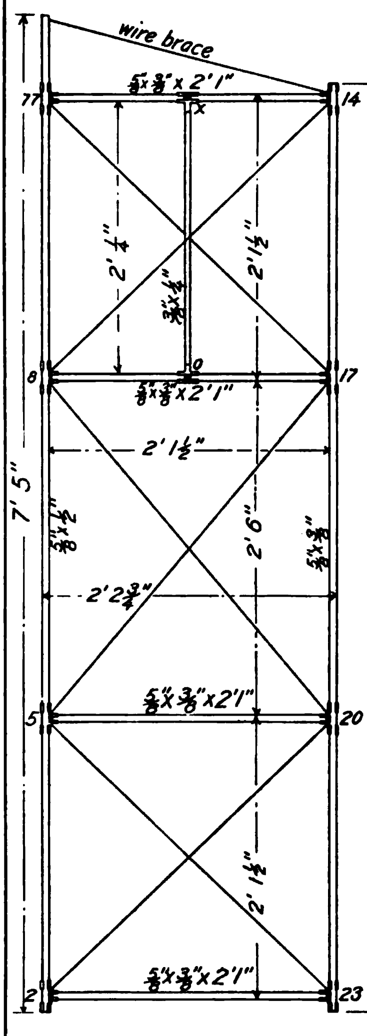

Fig. 2.
center

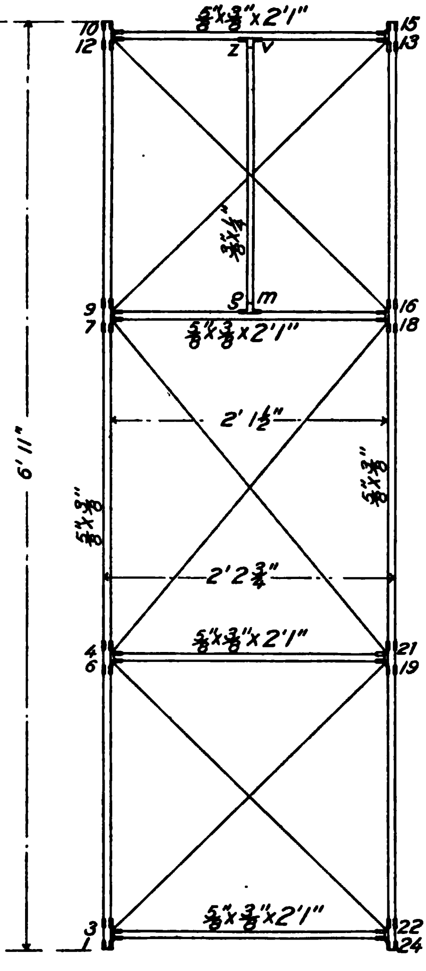

Fig. 3.
ends

wire about 6 feet long is bent so that a small open ring about an inch in diameter will be formed near one end; about an inch of the wire at each end is then bent at right angles, thus: |____o__| Wrap the soft iron wire tightly about the line and then tie the cord holding the secondary kite into the ring

The half tone, plate 6, is reproduced from Vol. I, part 1, Bulletin of Mount Weather Observatory, and shows the method of attaching the meteorograph to the head kite.

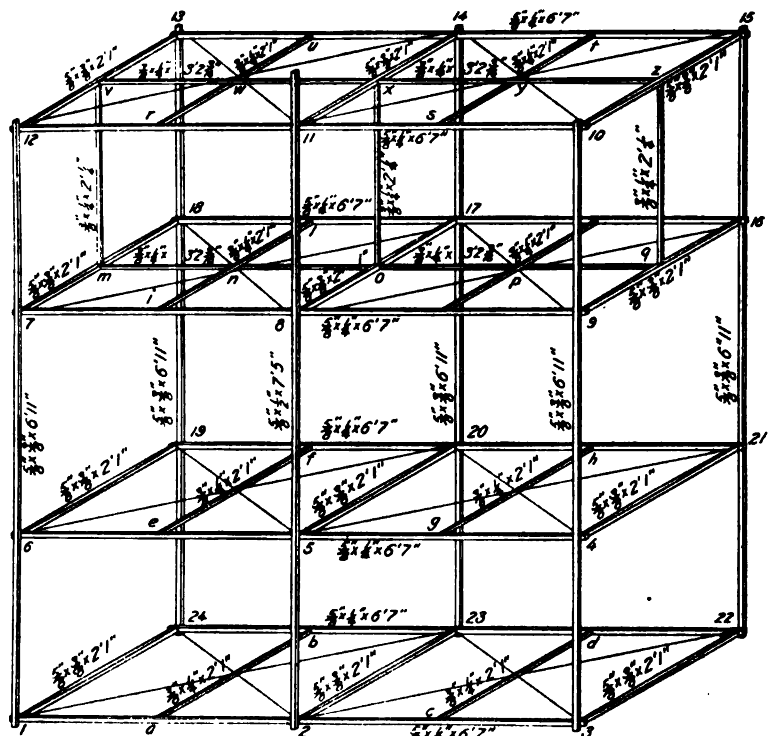

Fig. 4.
Isometric view.

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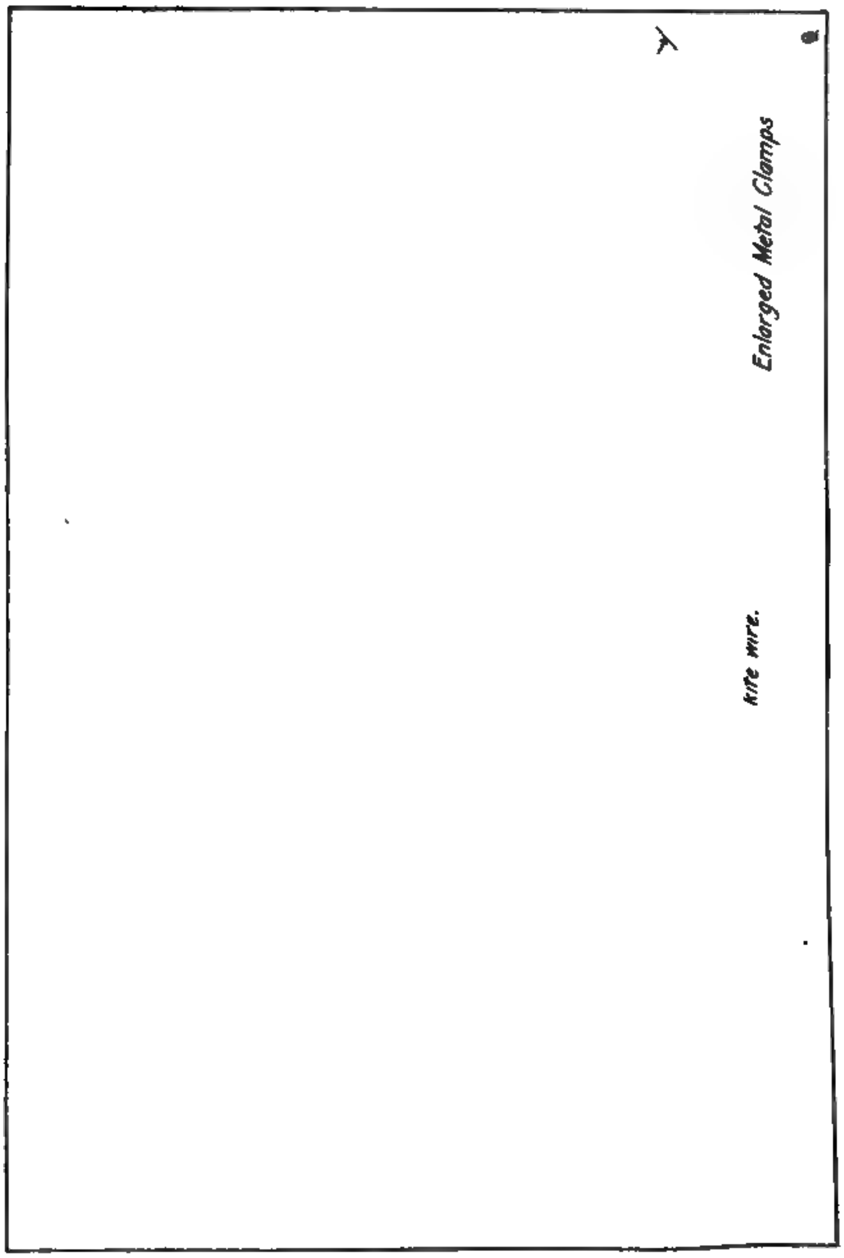
A SIMPLE FORM OF TAILLESS KITE.

In the Agricultural Yearbook for 1898 Prof. C. F. Marvin, of the Weather Bureau, illustrated and described the construction of a simple form of cellular kite. The kite now to be described is of the Marvin construction, with a few slight exceptions, which were thought to be necessary after experimenting at the Mount Weather kite station during the summer of 1909.

Figure 8 shows such a simple form of kite complete, and figures 9, 10, and 11 show the details of the several parts. The sticks are


Enlarged Metal Clamps
kite wire.

made of straight grained spruce, but white pine will answer as well. Either Lonsdale cambric or calico may be used for the covering. Small tacks and coarse waxed linen thread are required. The sticks should be cut to the shape and dimensions shown in figures 9, 10, and 11 in detail.

The kite is constructed upon a central truss, which is shown in figure 9. The longitudinal sticks, *a* and *c* figure 8, are ¼ inch × ⅝ inch × 40 inches. At 5⅜ inches from each end a slight notch, which should not exceed $\frac{1}{16}$ inch in depth, as shown at *N* figure 9 is formed to receive the uprights. The uprights which are cut as shown in figure 9 must have their ends perfectly square and true. They must be seated squarely in the notches of the long spines and be firmly lashed in place with coarse waxed linen thread.

Figure 10 shows the form to which the corner longitudinal spines *A*, *B*, *C*, *D* (fig. 8) should be dressed; the long straight edges are to be slightly rounded as shown in section. Notice that the distances of the notches from the opposite ends are not the same.

The covering for the kite is made of two long strips of cloth. Both edges of the strips should be hemmed even if the edge has selvage, and when so hemmed the width should be just 12 inches. The total length of the strip, when stretched as it will be on the kite, should be 96½ inches, the half inch being allowed for the lap of the cloth in sewing the ends together. The opposite end of each cloth strip should be carefully and evenly overlapped for half an inch and strongly sewed together with a double seam, thus forming two endless bands.

The next step is to mark the cloth bands at the places that are to be fastened to the frame. Stretch each cloth band out smooth and straight over two thin sticks run through inside the band. It is well to make the seam in the band come over or near the edge of one of the sticks. When the band is smooth and evenly stretched, draw a pencil line across the band exactly in the middle, where it turns around the edge of each stick.

The cloth bands are now ready to be tacked to the frames of the kite. Put one of the bands over the central truss and tack from *a* to *b*, figure 8, with a few small 2-ounce tacks along the top stick of the truss. The lower side must be tacked in a similar manner to the opposite truss, from *c* to *d*, figure 8, care being taken that the truss is exactly in the center of the cloth band. The other band is tacked in a similar manner to the other end of the kite frame. Finally, the four corner longitudinal spines are passed within the bands, taking special care that the notches in the spines will stand in their proper relation. Referring to figure 10, it will be recalled that the small notch at one end of each spine is nearer its end than the opposite notch is to its end. This is done in order that the diagonal struts shall pass on each side of the uprights of the central truss as shown at *o*, figure 11. In other

Fig. 9.

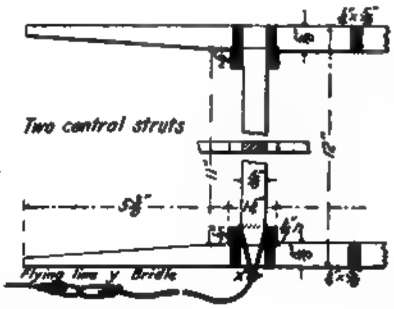


Fig. 11.

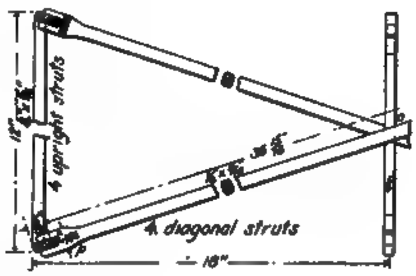


Fig. 10.

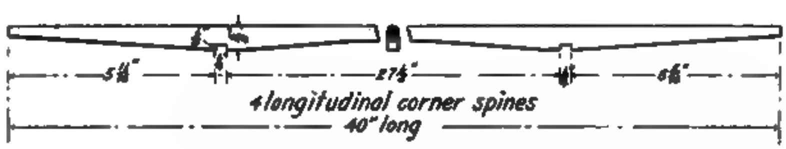


Fig. 8.

words, see that the short ends of the spines are in the A and C corners and the long ends in the B and D corners.

It is difficult to determine the exact length of the diagonal struts because the amount that the cloth bands will stretch is uncertain. The length indicated in figure 11 is about right if all the other dimensions are adhered to. In order to be sure that the diagonal struts fit in the proper manner it will be found better to make up a pair of struts about half an inch too long at first, then by trying them in the kite and cutting out the notches deeper and deeper a perfectly satisfactory fit can be secured, and the cloth braced out smooth and taut. Care must be taken to keep all diagonal struts of the same length. This fitting had better be done before reducing the cross section of the spines between the forked ends. The forked ends when finished should have about the dimensions shown in figure 11 at P. In order to prevent the forks from splitting off it is quite necessary to lash the ends just back of the notch with a serving of good waxed thread. Instead of cutting these struts out of a solid piece, as assumed above, some may prefer to build up the forked enlargements at the ends by gluing on small cleats, finally lashing on the waxed thread over all as before. In order to prevent the sides of the kite from pressing in, four upright struts are provided, the ends of which are tacked to the corner spines close to the diagonal struts, as shown in figure 11. After the cloth has been stretched smoothly and evenly over the frame, it should be lashed securely to the corner spines and the central truss with stout twine, sewing through the cloth and around the sticks.

To bridle the kite cut off about 6 feet of stout cord and tie one end to the central truss as shown at E, figure 8, the cord passing through small holes pierced in the cloth covering. The knot employed at this point is shown at X, figure 9. The flying line should be tied to the free end of this cord by means of bowline knots as shown at Y. This knot is strong, never slips, and can be easily untied, no matter how much the line may have been strained.

To be perfectly safe the flying line of this kite should have a tensile strength of from 50 to 60 pounds, and be equally strong throughout. If the wind is favorable for flying, the best way to start the flight is to run out 150 feet or more of the twine while the kite is held by an assistant. When all is ready the assistant should toss the kite upward a little in the direction in which it is to go. It will then take care of itself. It is important that the kite be cast off directly in line with the wind, otherwise it may dart badly. When fairly up the kite may sweep a little from side to side, but if it ever darts or turns over there is something radically wrong, probably an uneven distribution of the cloth surface, or some distortion of the framework.

THE NEW KITE REEL.

By W. R. Blair.

This reel, originally designed by Professor Marvin and later modified by the writer, will carry 20,000 meters of wire and run at any speed from 0.8 to 9.5 kilometers per hour. The drum carrying the

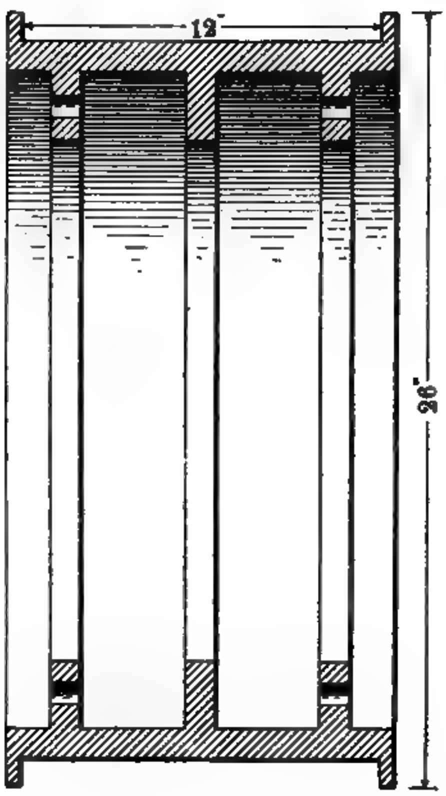


Fig. 1. Fig. 2. Fig. 3.
THE NEW KITE REEL.
Detail of drum, showing construction of barrel and spider.

wire is 2 feet in diameter, the throat being 12 inches wide by 1 inch deep. These and other details of construction are shown in the accompanying sketches (figs. 1, 2, and 3). The construction here shown is the one adopted after trial of two one-piece castings, one of which was iron,

the other steel. It seemed impossible to properly distribute the material of the one-piece drum so that it would withstand the peculiar strain to which the accumulating taut wire subjected it, without making it too heavy. The form in use is cast in three pieces, the barrel and two spiders. The barrel is made of semisteel casting and is designed to carry the entire strain, the spiders being light iron castings which serve to center the barrel on the shaft and rotate it.

On the same shaft with the drum are mounted two separate brakes, a hand brake and a foot brake. Either brake is usually sufficient for the control of the drum as the kites go out; both may be used simultaneously if necessary. This shaft also carries two driven gears of different diameter, the larger one being for slower speeds. The gears engaging these are always in mesh and power is applied to either of them at will by means of a double-throw friction clutch. The source of power is a reversible, variable-speed, electric motor which runs at from 330 to 1,000 revolutions per minute. This power is transmitted to the shaft carrying the double-throw clutch by means of chain and sprockets. The switchboard for the motor and all clutch and brake levers are brought to the right side of the reel and within easy reach of the operator. Plates 5 and 6 show this arrangement.

The reel is insulated from the floor of the reel house and from the power system and carefully grounded through a single wire so that the current coming down the kite wire may be measured.

UPPER AIR DATA FOR APRIL, MAY, AND JUNE, 1909.

By the Aerial Section—Wm. R. Blair in charge.

The mean of the highest altitudes reached daily during the three months is 2,420 meters. Kites were used during April and May and twenty-one days in June, captive balloons being used but five times. The mean of highest altitudes reached with balloons is 1,896 meters. The highest kite flight of the period is 4,431 meters above sea level, while the highest balloon ascension is 2,358 meters.

The prevailing wind for the period was northwest, though southeast winds were nearly as frequently observed. The average hourly wind velocity for April was 27.5 kilometers. This decreased to 16.4 kilometers for June. This is in keeping with the decrease in sharpness and range of the barometric changes during the period. The frequency of inversions of temperature has decreased decidedly during the three months, and the whole number observed is much less than for the three months previous. There is a decrease in the abruptness with which the isotherms change level, as well as in their range of altitude, as shown by Charts XIX to XXIV, inclusive. This, together with the barogram for the period, indicates that the observed decrease in the velocity of the horizontal air currents is accompanied by or accompanies a decrease in the vertical.

The vertical temperature gradient for April and May is characteristically large from the surface up to the altitudes reached by the kites. This observation supports the conclusion reached by Hann[a] and others, that at the 5,000 to 7,000 meter level the period of minimum temperature occurs in the spring months.

Figures 1, 2, and 3 show the mean daily surface temperatures for the three months, respectively, at Audley, Trapp, and Mount Weather. The daily range in temperature has increased consider-

[a] Hann's Lehrbuch der Meteorologie, 2d ed., p. 123. Bulletin Mount Weather Observatory, vol. 1, part 4.

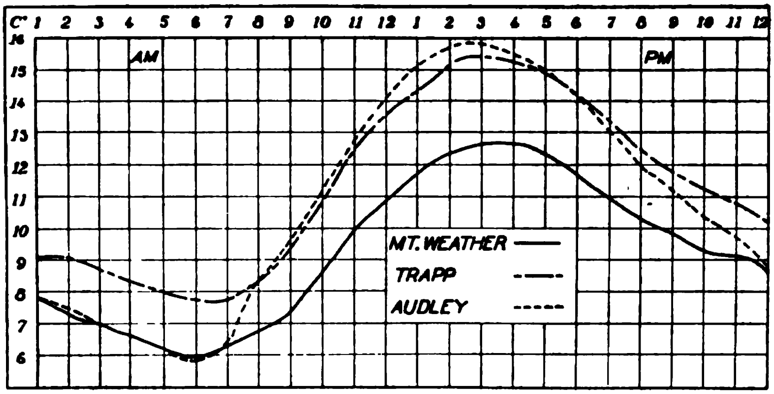


FIG. 1.—Mean hourly temperatures, April, 1909.

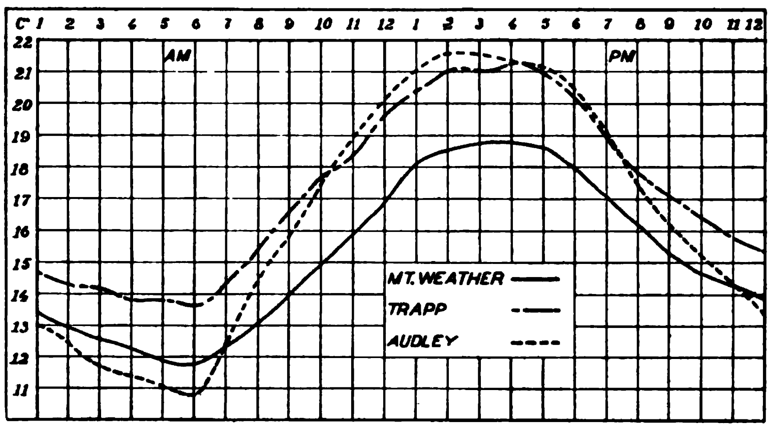


FIG. 2.—Mean hourly temperatures, May, 1909.

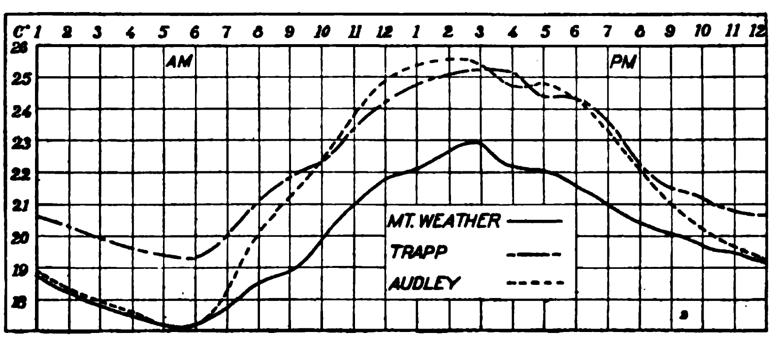


FIG. 3.—Mean hourly temperatures, June, 1909.

ably over that of the winter months, somewhat in agreement with the following summary of cloud observations:

Month.	Number of days.			Mean.
	Clear.	Partly cloudy.	Cloudy.	
April	7	11	12	5.7
May	8	16	7	5.4
June	6	14	10	5.9

RESULTS OF KITE FLIGHTS.

[April 1, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
9:57 a. m.	717.6	4.6	53	NW.	12.1	526	717.6	4.6	53	NW.	12.1
11:02 a. m.	717.7	6.6	45	NW.	8.9	972	679.6	3.3	....	WNW.	....
11:27 a. m.	717.3	6.8	44	NW.	6.7	1,153	663.7	0.3	....	NW.	....
1:46 p. m.	715.6	9.6	34	NW.	5.8	526	715.6	9.6	34	NW.	5.8

Four kites were used; lifting surface, 25.2 sq. m. Wire out, 1,800 m., at maximum altitude.

There were from 2/10 to 4/10 ci.-st. moving from the northwest. The weather was hazy.

Moderately high pressure covered the Middle Atlantic States; lows of small intensity were central off Nova Scotia and the southern coast of Florida.

[April 2, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
1:05 p. m.	713.0	6.7	62	NW.	8.0	526	713.0	6.7	62	NW.	8.0
1:20 p. m.	713.0	6.0	72	NW.	8.5	813	688.4	3.0	....	NW.	....
1:32 p. m.	713.0	5.6	79	NW.	8.5	972	674.9	1.1	....	NW.	....
2:28 p. m.	713.0	3.2	99	NW.	7.6	890	681.6	−0.1	....	NW.	....
2:36 p. m.	713.0	3.1	99	NW.	8.5	526	713.0	3.1	99	NW.	8.5

Three kites were used; lifting surface, 18.9 sq. m. Wire out, 1,200 m., at maximum altitude.

The sky was obscured by st. moving from the northwest. Light rain fell after 1:11 p. m. and light fog prevailed after 2:25 p. m. Low st. passed under the head kite from 1:40 to 2:18 p. m.

A high was central over New England and a low over the South Carolina coast.

RESULTS OF KITE FLIGHTS.

[April 3, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	*°C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	*°C.*	*p. ct.*		*m. p. s.*
7:34 a. m...	709.0	2.2	82	WSW.	6.7	526	709.0	2.2	82	WSW.	6.7
8:06 a. m...	709.0	1.5	89	W.	5.8	1,065	662.9	− 1.5	....	SW.	....
9:22 a. m...	708.8	2.2	94	WNW.	5.4	1,814	602.5	− 7.8	....	WNW.	....
10:43 a. m...	707.5	3.3	89	NW.	5.8	2,200	572.4	−10.8	....	WNW.	....
11:18 a. m...	707.7	4.4	84	NW.	6.7	1,806	602.5	− 7.7	....	WNW.	....
11:39 a. m...	707.4	5.6	71	NW.	8.0	1,295	642.9	− 3.8	....	WNW.	....
11:51 a. m...	707.4	6.6	57	WNW.	8.5	999	667.3	− 0.6	....	WNW.	....
11:58 a. m...	707.3	6.4	57	NW.	8.0	526	707.3	6.4	57	NW.	8.0

Five kites were used; lifting surface, 31.5 sq. m. Wire out, 4,000 m.; at maximum altitude, 3,500 m.

Nb. moving from the west-southwest covered the sky at the beginning. By 10:10 a. m. these had been succeeded by st.-cu. and st. moving from the west-northwest. Only st.-cu., covering 5/10 of the sky, after 11 a. m. Light rain fell until 8 a. m., snow until 8:50, and light rain again until 9:25 and from 10:01 to 10:05 a. m. The head kite was hidden by clouds at intervals from 9:45 to 11:36 a. m.

Pressure was low over the Lake region and the North Atlantic States and was high over the western Gulf.

[April 5, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity					Direction.	Velocity.
	mm.	*°C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	*°C.*	*p. ct.*		*m. p. s.*
1:14 p. m....	716.3	15.3	46	SE.	4.9	526	716.3	15.3	46	SE.	4.9
1:30 p. m....	716.3	15.7	45	SE.	5.4	772	696.1	19.4	....	SSW.	....
2:29 p. m....	716.2	17.8	41	SE.	5.8	1,317	653.2	15.6	....	SW.	....
3:08 p. m....	716.0	19.2	41	SE.	4.9	2,124	593.4	9.6	....	SW.	....
3:28 p. m....	715.9	20.3	38	SE.	4.9	3,534	500.1	2.2	....	W.	....
3:40 p. m....	715.9	19.4	38	SE.	4.9	3,812	482.6	−1.1	....	W.	....
5:30 p. m....	715.5	19.1	42	ESE.	7.2	2,800	546.9	5.9	....	W.	....
6:26 p. m....	715.5	17.7	46	ESE.	6.3	1,782	617.8	13.4	....	SW.	....
6:36 p. m....	715.5	17.4	46	ESE.	7.2	1,348	650.3	17.8	....	WSW.	....
6:45 p. m....	715.5	17.4	45	ESE.	6.7	857	688.6	19.6	....	S.	....
6:54 p. m....	715.5	17.3	46	ESE.	6.7	526	715.5	17.3	46	ESE.	6.7

Four kites were used; lifting surface, 25.7 sq. m. Wire out, 5,200 m. at the maximum altitude.

The sky was cloudless until 3:40 p. m., when a few ci.-st. moving from the west appeared. The clouds increased to 4/10 by the end of the flight.

Pressure was high over Florida and southern New England. A trough of low pressure extended from Wisconsin southwestward.

RESULTS OF KITE FLIGHTS.

[April 6, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
9:20 a. m...	718.1	20.0	28	SSW.	5.4	526	718.1	20.0	28	SSW.	
10:09 a. m...	717.8	20.9	30	SSW.	6.3	1,044	676.2	17.5	....	SSW.	....
11:16 a. m...	717.5	21.1	42	SSW.	4.5	1,353	651.6	14.7	....	SW.	....
12:10 p. m...	717.3	22.3	38	S.	4.5	1,814	617.1	11.5	....	SW.	....
12:38 p. m...	717.2	23.4	38	SSE.	7.6	2,106	596.2	10.1	....	SW.	....
1:00 p. m...	716.7	24.4	35	S.	6.7	3,168	524.5	3.4	....	WSW.	....
1:29 p. m...	716.4	24.5	36	S.	8.5	3,438	507.2	1.3	....	WSW.	....
1:54 p. m...	716.0	24.8	38	S.	8.5	4,431	447.2	−7.4	....	WSW.	....
2:34 p. m...	715.7	24.9	37	S.	6.7	3,880	480.1	−0.9	....	WSW.	....
2:57 p. m...	715.8	24.5	38	S.	8.5	3,757	486.7	−2.2	....	SW.	....
3:39 p. m...	715.8	24.2	43	S.	4.5	2,697	553.0	2.8	....	SW.	....
3:51 p. m...	716.0	23.3	48	W.	4.9	1,715	622.6	7.5	....	SW.	....
4:04 p. m...	716.1	17.7	86	WNW.	11.6	1,116	666.3	11.5	....	W.	....
4:16 p. m...	716.0	16.7	98	WNW.	2.7	526	716.0	16.7	98	WNW.	2.7

Five kites were used; lifting surface, 31.5 sq. m. Wire out, 7,000 m. at maximum altitude.

Ci.-st. covered from 3/10 to 8/10 of the sky until 2:45 p. m., when it gave place to a.-st., closely followed by st., all moving from the west. Light haze prevailed. A solar halo was visible at intervals until 2:30 p. m. A thunderstorm, approaching from the west, was heard first at 2:50, last at 4:30 p. m. After 3:45 p. m. the wire was heavily charged with electricity.

At 8 a. m. pressure was high over the south Atlantic coast. A low was central over eastern Kansas.

[April 7, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
7:35 a. m...	712.1	18.7	48	SW.	6.7	526	712.1	18.7	48	SW.	6.7
7:41 a. m...	712.0	18.7	48	SW.	6.7	999	673.9	16.8	....	SW.	....
8:05 a. m...	712.0	18.9	46	SW.	6.7	1,661	623.2	12.7	....	SW.	....
8:40 a. m...	712.0	18.2	48	SW.	6.7	2,040	595.4	10.0	....	WSW.	....
8:59 a. m...	712.0	18.5	49	SW.	5.8	2,692	549.9	4.9	....	WSW.	....
9:27 a. m...	712.0	19.8	47	SW.	5.4	2,996	530.2	3.0	....	WSW.	....
9:55 a. m...	712.0	20.0	46	WSW.	7.6	1,975	599.8	7.0	....	WSW.	....
10:14 a. m...	711.9	20.4	45	WSW.	8.5	1,428	640.3	10.5	....	WSW.	....
10:38 a. m...	711.8	21.2	45	WSW.	8.5	1,256	653.5	12.5	....	WSW.	....
10:49 a. m...	711.7	21.0	45	WSW.	8.0	911	680.6	16.0	....	WSW.	....
11:01 a. m...	711.7	21.3	46	W.	8.0	526	711.7	21.3	46	W.	8.0

Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,600 m. at maximum altitude.

4/10 to 9/10 st. moving from the west-southwest. About 2/10 a.-st. from the west-southwest after 8:10 a. m.

Low pressure was central over upper Michigan and high over Florida and Montana.

RESULTS OF KITE FLIGHTS.

[April 8, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	*°C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	*°C.*	*p. ct.*		*m. p. s.*
12:56 p. m.	719.7	11.3	27	WNW.	8.9	526	719.7	11.3	27	WNW.	8.9
1:16 p. m.	719.7	11.4	26	WNW.	7.2	783	697.7	8.6	....	W.	....
1:49 p. m.	719.6	12.0	28	WNW.	6.3	1,084	672.8	5.9	....	WSW.	....
2:20 p. m.	719.2	12.2	27	WNW.	5.8	526	719.2	12.2	27	WNW.	5.8
Second flight.											
3:47 p. m.	718.2	11.8	36	SW.	5.8	526	718.2	11.8	36	SW.	5.8
4:15 p. m.	718.1	11.1	39	SSW.	4.5	874	688.7	7.6	....	SSW.	....
4:29 p. m.	718.1	11.1	38	S.	6.3	1,231	659.3	4.7	....	SW.	....
4:44 p. m.	718.0	11.1	36	SSW.	6.7	1,719	620.6	−0.7	....	SW.	....
5:15 p. m.	717.8	10.7	38	S.	6.3	1,954	601.9	−4.3	....	SW.	....
5:57 p. m.	717.5	9.6	43	S.	6.3	2,388	569.0	−8.8	....	SW.	....
6:17 p. m.	717.4	9.4	46	S.	6.3	1,947	601.9	−4.0	....	SW.	....
6:24 p. m.	717.3	9.4	44	S.	7.2	1,461	639.8	0.8	....	SSW.	....
6:36 p. m.	717.3	9.3	44	S.	6.3	784	695.4	7.0	....	SSW.	....
6:44 p. m.	717.2	9.2	46	SSW.	6.7	526	717.2	9.2	46	SSW.	6.7

First flight: Three kites were used; lifting surface, 18.9 sq. m. Wire out, 1,200 m. at the maximum altitude.

The sky was obscured by stratus clouds, moving from the west-northwest.

Second flight: Five kites were used; lifting surface, 32.0 sq. m. Wire out, 5,000 m.; at the maximum altitude, 3,900 m.

The sky was overcast with stratus clouds, moving from the west.

At 8 a. m. an area of low pressure was moving down the St. Lawrence Valley, and an extensive high was central over Colorado, its influence extending to the middle Atlantic coast.

[April 9, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	*°C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	*°C.*	*p. ct.*		*m. p. s.*
8:52 a. m.	713.5	0.9	49	WNW.	17.0	526	713.5	0.9	49	WNW.	17.0
9:01 a. m.	713.4	1.1	42	WNW.	14.8	891	681.5	− 4.1	....	WNW.	....
9:29 a. m.	713.0	0.6	40	WNW.	13.4	1,577	623.6	−11.9	....	WNW.	....
9:45 a. m.	713.5	1.0	40	WNW.	13.0	2,183	576.4	−16.7	....	W.	....
10:13 a. m.	713.3	1.2	35	WNW.	15.2	2,454	556.2	−18.8	....	WNW.	....
10:39 a. m.	713.0	1.3	45	WNW.	15.6	2,616	544.1	−14.8	....	W.	....
11:49 a. m.	712.0	2.2	41	WNW.	16.1	3,281	498.5	−19.5	....	W.	....
12:04 p. m.	712.7	3.2	47	WNW.	17.4	3,113	510.4	−21.0	....	W.	....
12:50 p. m.	712.9	3.3	35	W.	14.8	2,593	546.8	−18.0	....	W.	....
1:57 p. m.	713.3	2.2	41	WNW.	13.0	1,432	636.1	− 9.1	....	W.	....
2:17 p. m.	713.2	3.2	31	W.	14.3	1,038	669.0	− 4.2	....	W.	....
2:37 p. m.	713.1	2.6	33	W.	14.3	526	713.1	2.6	33	W.	14.3

Four kites were used; lifting surface, 25.2 sq. m. Wire out, 6,400 m.; at maximum altitude, 5,600 m.

St.-cu. moving from the west-northwest decreased from 5/10 at the beginning to 2/10 at 11:15 a. m. and increased to 7/10 at the end. Passing clouds obscured the head kite at intervals from 9:35 a. m. to 12:44 p. m.

Low pressure was central over southern New York. Centers of high pressure lay over South Dakota and over Texas.

RESULTS OF KITE FLIGHTS.

[April 10, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
8:45 a. m...	718.1	−3.9	63	WNW.	9.8	526	718.1	− 3.9	63	WNW.	9.8
8:56 a. m...	718.3	−3.9	63	WNW.	9.8	900	684.8	− 8.8	....	NW.	....
9:10 a. m...	718.4	−3.9	63	NW.	9.8	1,264	653.2	−12.4	....	NW.	....
10:12 a. m...	718.9	−3.4	75	NW.	9.8	2,004	592.8	−19.8	....	NW.	....
10:37 a. m...	719.1	−2.3	68	NW.	11.6	2,489	556.1	−23.0	....	NW.	....
11:14 a. m...	719.5	−1.6	54	NW.	13.9	2,924	525.4	−24.2	....	NW.	....
11:53 a. m...	720.0	−1.2	52	NW.	13.4	2,534	553.9	−22.8	....	NW.	....
12:10 p. m...	720.2	−1.3	52	NW.	13.9	2,000	595.0	−18.7	....	NW.	....
12:25 p. m...	720.3	−1.2	52	WNW.	14.3	1,471	637.8	−15.3	....	WNW.	....
12:37 p. m...	720.4	−1.8	53	WNW.	14.3	1,026	675.9	− 9.7	....	WNW.	....
12:52 p. m...	720.5	−0.7	49	WNW.	13.9	526	720.5	− 0.7	49	WNW.	13.9

Five kites were used; lifting surface, 31.5 sq. m. Wire out, 7,000 m.; at maximum altitude, 6,000 m.

3/10 to 8/10 st.-cu. moving from the northwest. Light snow fell from 10:17 to 10:30 and from 11:40 until the close of the flight. The head kite was in the clouds at intervals from 9:19 to 11:53 a. m., when it emerged from the clouds at an altitude of 2,534 m.

High pressure was central over the upper Lakes and low over the Gulf of St. Lawrence.

[April 12, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
7:18 a. m...	726.8	− 0.8	89	SE.	6.7	526	726.8	− 0.8	89	SE.	6.7
7:24 a. m...	726.8	− 0.7	86	SE.	6.7	867	....	4.1	....	S.	....
7:35 a. m...	726.9	− 0.3	87	SE.	6.7	1,215	....	4.6	....	SSW.	....
7:53 a. m...	727.0	− 0.3	87	SE.	7.2	1,725	626.8	0.6	....	SSW.	....
8:50 a. m...	727.0	1.7	91	SE.	7.6	2,154	594.6	− 0.5	....	SSW.	....
10:25 a. m...	726.9	6.9	67	SE.	7.6	2,106	598.3	− 3.1	....	SSW.	....
11:11 a. m...	726.7	8.5	60	SE.	8.0	2,590	562.8	3.2	....	SSW.	....
11:32 a. m...	726.2	9.3	56	SE.	7.2	3,341	512.4	− 1.5	....	SSW.	....
11:43 a. m...	726.0	9.4	54	SE.	7.6	2,691	556.1	2.4	....	SSW.	....
1:59 p. m...	724.7	13.2	49	SSE.	6.3	2,336	581.4	− 0.5	....	SSW.	....
2:26 p. m...	724.6	13.6	49	SSE.	7.6	1,617	634.8	1.2	....	SSW.	....
2:41 p. m...	723.8	13.2	49	SE.	7.2	1,201	667.3	5.4	....	S.	....
2:54 p. m...	723.5	13.6	49	SE.	6.3	914	....	8.3	....	SSE.	....
3:01 p. m...	723.4	13.1	49	SE.	6.3	526	723.4	13.1	49	SE.	6.3

Four kites were used; lifting surface, 25.2 sq. m. Wire out, 6,750 m.; at the maximum altitude, 6,500 m.

The sky was nearly covered with ci.-st., moving from the west at the beginning of the flight. These had disappeared at 12:30 p. m., but 3/10 were again present at the end. A few st.-cu. moving from the south-southwest at the beginning, increased to 8/10 by 8:40 a. m. and decreased to 3/10 by the end. Solar halo.

Pressure was high off the north Atlantic coast and a trough of low pressure extended from Lake Superior southwestward.

RESULTS OF KITE FLIGHTS.

[April 13, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
1:27 p. m....	714.5	13.8	100	SE.	10.3	526	714.5	13.8	100	SE.	10.3
1:35 p. m....	714.3	13.9	100	SE.	11.2	784	692.8	12.5	....	SSE.	....
2:10 p. m....	713.5	14.0	100	SE.	10.7	526	713.5	14.0	100	SE.	10.7

One kite was used; lifting surface, 5.4 sq. m. Wire out, 1,000 m., at maximum altitude.

Dense fog until 1:47 p. m. and light fog thereafter. Light rain fell throughout the flight.

Low pressure was central over Lake Huron and high off the north Atlantic coast.

RESULTS OF KITE FLIGHTS.

[April 14, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
1:06 p. m...	716.8	6.6	100	NW.	8.0	526	716.8	6.6	100	NW.	8.0
2:32 p. m...	716.8	6.2	100	NW.	8.9	796	693.6	4.7	....	NNW.	....
2:36 p. m...	716.8	6.2	100	NW.	9.4	526	716.8	6.2	100	NW.	9.4

Three kites were used; lifting surface, 18.0 sq. m. Wire out, 1,925 m.; at the maximum altitude, 400 m.

Light rain and dense fog during the flight.

High pressure was central over Lake Huron and low pressure over North Carolina.

RESULTS OF KITE FLIGHTS.

[April 15, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°.	p. ct.		m. p. s.
9:52 a. m...	720.3	6.7	83	WNW.	11.6	526	720.3	6.7	83	WNW.	11.6
10:12 a. m...	720.4	7.0	81	WNW.	7.6	815	695.4	3.2	....	NW.	....
11:00 a. m...	720.4	8.3	73	WNW.	9.8	949	684.2	10.2	....	NW.	....
11:04 a. m...	720.4	8.7	69	NW.	10.3	1,396	648.3	6.5	....	WNW.	....
12:06 p. m..	719.9	10.3	62	NW.	8.9	1,084	673.0	9.9	....	W.	....
12:20 p. m..	719.9	10.6	63	NW.	10.7	867	690.9	6.8	....	NW.	....
12:34 p. m..	719.9	10.6	63	NW.	8.9	526	719.9	10.6	63	NW.	8.9

Four kites were used; lifting surface, 25.2 sq. m. Wire out, 3,000 m.; at the maximum altitude, 2,150 m.

At the beginning of the flight about 8/10 st.-cu., moving from the northwest; decreasing to about 5/10 by 10:30 a. m. and to few by 11:45 a. m. Dense haze.

At 8 a. m. a low was central off the southern New England coast, and a moderate high over Wisconsin and Minnesota.

RESULTS OF KITE FLIGHTS.

[April 16, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.	Height.	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
11:34 a. m.	723.7	10.8	62	SE.	6.7	526	723.7	10.8	62	SE.	6.7
11:40 a. m.	723.7	11.1	63	SE.	6.7	880	693.6	8.4	....	SSE.	....
11:50 a. m.	723.7	11.7	62	SE.	6.7	962	686.9	10.7	....	S.	....
1:46 p. m.	722.5	14.9	53	SE.	6.8	1,994	606.1	7.1	....	WSW.	....
2:00 p. m.	722.4	15.4	52	SE.	7.2	2,661	558.5	2.6	....	WSW.	....
2:25 p. m.	722.2	15.8	52	SE.	6.7	4,273	454.6	−10.8	....	W.	....
3:12 p. m.	721.8	16.6	46	SE.	5.8	3,944	474.2	− 9.1	....	W.	....
4:17 p. m.	721.6	15.6	53	SE.	6.3	3,425	506.9	− 3.7	....	W.	....
4:57 p. m.	721.6	16.8	53	SE.	5.8	2,806	547.5	− 1.5	....	W.	....
5:20 p. m.	721.6	16.3	53	SE.	7.2	1,591	635.7	8.2	....	SW.	....
5:35 p. m.	721.6	15.7	56	SE.	5.4	1,362	653.3	9.4	....	S.	....
5:46 p. m.	721.6	15.4	56	SE.	4.0	916	689.1	11.3	....	SE.	....
5:55 p. m.	721.6	15.3	56	SE.	3.6	526	721.6	15.3	56	SE.	3.6

Six kites were used; lifting surface, 38.3 sq. m. Wire out, 6,000 m., at maximum altitude.

Cloudless until 12:04 p. m. then a few ci.-st., moving from the west. These gradually increased to 8/10 at 4:25 p. m. and decreased to 3/10 at the close of the flight.

High pressure was central over eastern Pennsylvania and Maryland and low over northern Texas.

RESULTS OF KITE FLIGHTS.

[April 17, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.	Height.	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
7:11 a. m.	720.5	17.1	55	WSW.	8.9	526	720.5	17.1	55	WSW.	8.9
7:19 a. m.	720.5	17.6	52	SW.	10.3	918	688.3	17.6	....	SW.	....
7:37 a. m.	720.5	17.6	53	WSW.	9.8	1,283	659.4	15.6	....	WSW.	....
8:06 a. m.	720.5	17.9	52	WSW.	11.2	1,946	608.7	7.8	....	WSW.	....
8:26 a. m.	720.4	18.9	50	WSW.	10.7	2,465	571.7	4.2	....	W.	....
8.59 a. m.	720.3	19.5	48	WSW.	8.5	2.971	537.1	0.6	....	W.	....
9:24 a. m.	720.3	20.5	44	W.	7.2	2,680	557.0	2.2	....	WSW.	....
9:52 a. m.	720.2	21.1	40	WSW.	6.7	2,023	603.4	7.1	....	WSW.	....
10.28 a. m.	720.1	22.3	38	WSW.	7.6	1,426	648.3	12.9	....	WSW.	....
10:40 a. m.	720.1	22.4	35	SW.	6.3	860	692.9	18.1	....	WSW.	....
10:44 a. m.	720.1	22.6	36	WSW.	8.5	526	720.1	22.6	36	WSW.	8.5

Three kites were used; lifting surface, 18.9 sq. m. Wire out, 6,000 m.; at maximum altitude, 5,930 m.

A few ci.-st. near the horizon after 7:30 a. m.

Pressure was high over the south Atlantic seaboard, and was relatively low over the St. Lawrence Valley.

RESULTS OF KITE FLIGHTS.

[April 19, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.	Height.	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.
	mm.	°C.	p.ct.		m.p.s.	meters.	mm.	°C.	p.ct.		m.p.s.
7:25 a. m...	715.0	20.8	40	WSW.	7.2	526	715.0	20.8	40	WSW.	7.2
7:36 a. m...	715.0	21.0	40	WSW.	6.7	926	682.8	19.2	....	WSW.	....
7:47 a. m...	715.0	21.1	40	WSW.	7.6	1,299	653.4	15.6	....	WSW.	....
8:14 a. m...	714.9	21.8	42	WSW.	6.7	1,849	612.5	11.7	....	WSW.	....
9:14 a. m...	714.6	23.4	36	SW.	8.0	2,581	560.8	5.5	....	SW.	....
11:22 a. m...	713.7	25.3	38	SW.	5.8	1,783	616.4	10.0	....	SSW.	....
11:34 a. m...	713.6	24.9	38	SW.	5.4	1,289	653.4	16.2	....	SW.	....
11:45 a. m...	713.4	26.1	37	S.	4.9	824	689.5	20.2	....	S.	....
11:55 a. m...	713.3	26.1	37	S.	4.5	526	713.3	26.1	37	S.	4.5

Three kites were used; lifting surface, 18.9 sq. m. Wire out, 5,600 m.; at the maximum altitude, 5,300 m.

A few ci.-st. moving from the west at the beginning had increased to 3/10 by the end of the flight. A few cu. moving from the southwest just as the flight ended.

Low pressure was central over western New York and high pressure over the south Atlantic coast.

RESULTS OF KITE FLIGHTS.

[April 20, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.	Height.	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.
	mm.	°C.	p.ct.		m.p.s.	meters.	mm.	°C.	p.ct.		m.p.s.
1:39 p. m....	713.2	4.8	100	ESE.	6.3	526	713.2	4.8	100	ESE.	6.3
1:51 p. m....	713.2	4.7	100	ESE.	7.6	944	677.4	4.3	....	ESE.	....
2:04 p. m....	713.2	4.7	100	ESE.	4.5	1,169	659.2	7.1	....	SE.	....
2:18 p. m....	713.2	4.8	100	E.	4.5	1,229	654.7	6.2	....	SE.	....
2:24 p. m....	713.2	4.7	100	N.	4.0	526	713.2	4.7	100	N.	4.0

Two kites were used; lifting surface, 12.6 sq. m. Wire out, 1,200 m., at maximum altitude.

Light rain and dense fog.

Pressure was high over Ontario. Low pressure was central over eastern Kentucky.

RESULTS OF KITE FLIGHTS.

[April 21, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
1:08 p. m....	715.8	6.1	100	ESE.	8.9	526	715.8	6.1	100	ESE.	8.9
1:14 p. m....	715.8	6.1	100	ESE.	10.3	921	682.2	4.2	....	SE.	....
1:17 p. m....	715.8	6.2	100	ESE.	10.7	526	715.8	6.2	100	ESE.	10.7

One kite was used; lifting surface, 6.3 sq. m. Wire out, 500 m., at maximum altitude.
Light rain and dense fog.
A high was central over New Brunswick and a low over Illinois.

RESULTS OF KITE FLIGHTS.

[April 22, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
7:13 a. m....	711.9	12.0	95	WNW.	5.4	526	711.9	12.0	95	WNW.	5.4
7:38 a. m....	711.9	12.3	88	NW.	6.3	828	686.8	12.6	....	WNW.	....
7:53 a. m....	711.9	12.2	86	NW.	7.6	1,505	633.4	9.4	....	SW.	....
8:03 a. m....	711.9	12.2	85	NW.	6.7	1,737	615.9	6.6	....	SW.	....
8:13 a. m....	711.9	12.3	84	NW.	7.2	1,964	599.2	8.5	....	WSW.	....
8:27 a. m....	711.9	12.6	82	NW.	7.2	1,737	615.9	9.0	....	WSW.	....
8:38 a. m....	711.9	12.8	81	WNW.	6.7	1,421	639.7	9.9	....	WSW.	....
8:43 a. m....	711.9	12.8	79	WNW.	6.7	801	689.0	11.5	....	WNW.	....
8:49 a. m....	711.9	12.7	80	WNW.	6.7	526	711.9	12.7	80	WNW.	6.7

Three kites were used; lifting surface, 19.4 sq. m. Wire out, 2,000 m.; at the maximum altitude, 1,940 m.

Light fog dissipated at 7 a. m., but remained in adjacent valleys until about 8 a. m. 1/10 to 3/10 st.-cu., moving from the northwest during the flight.

At 8 a. m. low pressure occupied the Lake region, Middle Atlantic and New England States. Pressure was moderately high over the Southern States.

RESULTS OF KITE FLIGHTS.

[April 23, 1909.]

Hour.	On Mount Weather, Va., 526 meters. Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.	At different heights above sea. Height.	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
1:35 p. m....	714.4	3.4	100	NNW.	9.4	526	714.4	3.4	100	NNW.	9.4
1:51 p. m....	714.4	3.9	100	NW.	8.0	915	680.8	−0.1	....	N.	....
2:00 p. m....	714.4	3.8	100	NNW.	7.2	1,104	664.9	−0.1	....	NNW.	....
2:14 p. m....	714.4	4.2	100	NW.	8.0	1,702	617.2	1.0	....	WNW.	....
2:31 p. m....	714.3	4.4	94	NW.	7.6	2,306	572.2	−2.6	....	W.	....
2:39 p. m....	714.3	4.4	94	NW.	7.2	2,519	556.9	−3.3	....	W.	....
3:15 p. m....	714.1	5.7	83	NW.	8.5	526	714.1	5.7	83	NW.	8.5

Three kites were used; lifting surface, 18.9 sq. m. Wire out, 4,000 m.; at maximum altitude, 3,670 m.

Light mist until 2:06, and light fog until 2:30 p. m. The st. cover, moving from the northwest, began to break at 3 p. m.

Centers of low pressure lay over the lower St. Lawrence, eastern Virginia, and western North Carolina. A ridge of high pressure extended from Minnesota to Texas.

RESULTS OF KITE FLIGHTS.

[April 24, 1909.]

Hour.	On Mount Weather, Va., 526 meters. Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.	At different heights above sea. Height.	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
7:11 a. m...	722.0	1.8	58	NW.	6.7	526	722.0	1.8	58	NW.	6.7
7:18 a. m...	722.1	1.8	58	NW.	7.2	789	698.8	−1.2	....	NNW.	....
7:42 a. m...	722.3	2.5	53	NW.	8.0	1,319	653.7	−6.1	....	NW.	....
7:48 a. m...	722.3	2.2	54	NW.	8.0	1,508	638.3	−2.6	....	NW.	....
8:10 a. m...	722.5	2.8	51	NW.	8.5	2,036	597.2	−5.2	....	NW.	....
8:24 a. m...	722.6	3.1	53	NW.	8.0	2,178	586.7	−4.4	....	NW.	....
9:24 a. m...	723.0	4.0	50	NW.	7.2	2,506	563.1	−6.4	....	NW.	....
9:40 a. m...	723.0	4.8	50	NW.	7.2	2,875	536.9	−8.1	....	NW.	....
10:16 a. m...	723.2	5.4	47	WNW.	8.0	2,313	578.5	−6.1	....	NW.	....
10:26 a. m...	723.2	5.3	47	WNW.	7.2	2,113	593.3	−3.7	....	N.	....
10:29 a. m...	723.2	5.6	47	WNW.	7.2	2,002	601.6	−5.0	....	N.	....
10:38 a. m...	723.3	6.1	46	WNW.	8.0	1,592	633.8	−2.3	....	NNW.	....
10:50 a. m...	723.3	6.3	44	WNW.	7.6	781	701.0	2.2	....	WNW.	....
11:02 a. m...	723.4	6.4	44	WNW.	7.6	526	723.4	6.4	44	WNW.	7.6

Four kites were used; lifting surface, 25.7 sq. m. Wire out, 6,300 m.; at maximum altitude, 5,000 m.

The sky was cloudless.

High pressure was central over Indiana and low over New Brunswick.

RESULTS OF KITE FLIGHTS.

[April 26, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
7:17 a. m.	713.8	10.3	79	NW.	8.5	526	713.8	10.3	79	NW.	8.5
7:26 a. m.	713.8	10.4	79	NW.	8.5	942	678.9	7.3	....	NW.	
7:42 a. m.	713.8	10.4	79	NW.	8.0	1,272	652.0	4.3	....	NW.	....
7:55 a. m.	713.8	10.8	79	NW.	8.0	1,828	609.3	2.9	....	NNW.	....
8:26 a. m.	713.9	10.7	78	NW.	12.1	2,363	570.4	0.3	....	NW.	....
8:41 a. m.	713.9	10.3	69	NW.	13.4	2,672	548.5	− 2.4	....	NW.	....
9:35 a. m.	714.2	11.7	47	NW.	9.8	3,481	494.8	− 9.1	....	NW.	....
9:52 a. m.	714.3	11.9	45	NW.	10.7	2,968	528.8	− 5.0	....	NW.	....
10:02 a. m.	714.3	11.9	43	NW.	8.9	2,376	570.4	1.1	....	NW.	....
10:12 a. m.	714.3	12.2	43	NW.	9.8	1,731	617.6	4.9	....	NW.	....
10:22 a. m.	714.4	12.2	42	NW.	11.2	1,396	643.4	6.7	....	NW.	....
10:36 a. m.	714.4	12.7	40	NW.	10.7	896	683.4	8.1	....	NW.	....
10:41 a. m.	714.4	12.8	40	NW.	9.4	526	714.4	12.8	40	NW.	9.4

Four kites were used; lifting surface, 25.2 sq. m. Wire out, 6,360 m.; at the maximum altitude, 6,100 m.

At the beginning 4/10 a.-st. moving from the west and 2/10 st.-cu. moving from the northwest. The clouds gradually decreased in amount and had disappeared by the end of the flight.

Low pressure was central off the north Atlantic coast and pressure was high over the lower Lakes.

RESULTS OF KITE FLIGHTS.

[April 27, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
6:56 a. m.	715.8	4.6	87	SE.	8.0	526	715.8	4.6	87	SE.	8.0
7:06 a. m.	715.8	4.7	86	SE.	8.0	922	682.1	5.7	....	S.	....
7:17 a. m.	715.8	4.9	86	SE.	8.5	1,282	653.0	9.0	....	S.	....
7:28 a. m.	715.8	5.1	86	SE.	8.0	1,631	626.1	6.4	....	SSW.	....
7:47 a. m.	715.8	5.3	86	SE.	8.9	2,002	593.9	3.3	....	SW.	....
8:41 a. m.	715.4	6.9	83	SE.	8.9	2,723	546.7	− 2.4	....	SW.	....
9:46 a. m.	715.1	8.7	75	SE.	8.9	3,145	518.2	− 4.7	....	SW.	....
10:17 a. m.	714.9	9.8	70	SE.	10.3	2,441	566.4	0.4	....	SW.	....
11:14 a. m.	714.4	10.8	62	SE.	10.3	1,870	606.8	3.6	....	SW.	....
11:35 a. m.	714.2	11.0	58	SE.	8.5	1,185	659.5	9.0	....	S.	....
11:43 a. m.	714.2	10.6	57	SE.	8.9	962	677.6	6.0	....	S.	....
11:55 a. m.	714.0	10.8	55	SE.	8.5	526	714.0	10.8	55	SE.	8.5

Five kites were used; lifting surface, 31.5 sq. m. Wire out, 6,700 m., at maximum altitude, 5,300 m.

3/10 to 8/10 st.-cu. moving from the southwest. Low st. from the southeast until 10:45 at an altitude of about 100 meters. The head kite entered the upper clouds at 8:53 and at 9:30 a. m. for short intervals.

Low pressure was central over Lake Huron and high off the north Atlantic coast.

RESULTS OF KITE FLIGHTS.

[April 28, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
7:19 a. m.	716.8	1.7	59	NW.	11.6	526	716.8	1.7	59	NW.	11.6
7:31 a. m.	717.0	1.4	59	NW.	12.1	1,075	669.3	−4.0	....	NW.	....
7:44 a. m.	717.2	1.8	52	NW.	12.5	1,345	647.2	1.0	....	NW.	....
8:29 a. m.	717.8	2.8	45	NW.	8.9	1,765	615.0	2.2	....	NW.	....
9:03 a. m.	718.2	3.8	44	NW.	8.9	2,572	556.9	0.0	....	NW.	....
9:13 a. m.	718.3	3.7	44	NW.	10.7	2,988	528.4	−3.1	....	NW.	....
9:53 a. m.	718.6	5.1	40	NW.	9.8	3,417	500.9	−5.6	....	NW.	....
10:18 a. m.	718.7	5.7	38	NW.	10.7	2,899	535.0	−2.7	....	NW.	....
10:48 a. m.	718.8	6.1	36	NW.	12.1	2,454	565.6	0.1	....	NW.	....
11:08 a. m.	718.9	6.7	37	NW.	10.7	2,216	583.1	−1.1	....	NW.	....
11:26 a. m.	719.0	7.1	37	NW.	10.7	1,621	627.9	2.0	....	NW.	....
11:30 a. m.	719.0	6.7	37	NW.	10.7	1,349	649.4	−1.9	....	NW.	....
11:46 a. m.	719.1	7.8	36	NW.	9.8	894	687.5	3.2	....	NW.	....
11:54 a. m.	719.1	7.8	37	NW.	8.0	526	719.1	7.8	37	NW.	8.0

Four kites were used; lifting surface, 25.2 sq. m. Wire out, 6,500 m.; at the maximum altitude, 5,800 m.

A few st.-cu. moving from the northwest until 8:12 a. m. The sky was cloudless from 8:12 until 11:54 a. m., when a few ci. appeared on the northwest horizon.

Pressure was high over the Lake region and low over the lower St. Lawrence with secondary depressions off the Massachusetts and North Carolina coasts.

RESULTS OF KITE FLIGHTS.

[April 29, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
6:55 a. m.	719.5	3.7	74	SE.	10.3	526	719.5	3.7	74	SE.	10.3
7:05 a. m.	719.5	3.9	73	SE.	10.7	890	688.0	1.9	....	SSE.	....
7:25 a. m.	719.5	4.4	72	SE.	13.0	1,380	647.7	6.0	....	S.	....
7:39 a. m.	719.4	4.2	72	SE.	11.6	1,966	602.8	4.2	....	SSW.	....
8:19 a. m.	719.4	5.3	68	SE.	10.7	1,625	628.4	6.0	....	S.	....
8:38 a. m.	719.3	5.9	66	SE.	10.7	1,185	663.2	3.1	....	SSE.	....
9:03 a. m.	719.3	5.0	69	SE.	11.2	888	688.0	1.7	....	SSE.	....
9:11 a. m.	719.3	5.2	69	SE.	10.3	526	719.3	5.2	69	SE.	10.3

Two kites were used; lifting surface, 12.6 sq. m. Wire out, 3,000 m., at the maximum altitude.

About 6/10 st.-cu., moving from the west until 8:30 a. m. At a lower elevation there were other st.-cu. clouds, which were moving from the southwest. The latter were scattering at first, amounting to from 2/10 to 4/10, but rapidly increased at about 8:30 a. m., entirely covering the sky by 8.45 a. m.

A low of great intensity and extent was central over Kansas, its influence being felt over practically the entire country. Pressure was high along the Atlantic coast.

RESULTS OF KITE FLIGHTS.

[April 30, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
8:33 a. m....	709.4	10.9	95	SSW.	5.8	526	709.4	10.9	95	SSW.	5.8
8:42 a. m....	709.4	11.1	94	SSW.	6.7	949	674.6	13.2	....	SW.	....
8:59 a. m....	709.4	11.4	93	SSW.	6.3	1,527	629.8	13.2	....	WSW.	....
9:08 a. m....	709.5	12.8	89	W.	9.8	1,758	612.7	11.6	....	WSW.	....
9:20 a. m....	709.6	9.0	92	WNW.	10.3	2,086	589.3	7.2	....	W.	....
9:27 a. m....	709.6	11.1	95	WNW.	12.1	526	709.6	11.1	95	WNW.	12.1

Two kites were used; lifting surface, 10.8 sq. m. Wire out, 3,500 m., at maximum altitude.

About 4/10 a.-st. moving from the west until 8:50 a. m. From 5/10 to 10/10 st. from the west throughout the flight. Light rain fell after 8:46 a. m. The head kite entered the clouds at 8:59 a. m.

Low pressure was central over Lake Michigan and high over New Brunswick.

RESULTS OF KITE FLIGHTS.

[May 1, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
8:59 a. m...	702.2	15.2	98	SSW.	6.7	526	702.2	15.2	98	SSW.	6.7
9:22 a. m...	702.6	10.8	85	NW.	9.8	808	679.2	8.4	....	NW.	....
9:37 a. m...	702.8	10.0	82	WNW.	11.6	871	674.2	10.7	....	WNW.	....
9:56 a. m...	702.9	9.5	78	WNW.	15.2	1,674	612.3	8.9	....	SW.	....
10:12 a. m...	703.1	9.3	78	WNW.	14.8	2,201	574.6	6.6	....	SW.	....
10:23 a. m...	703.2	9.2	77	NW.	17.4	2,475	555.6	4.6	....	SW.	....
10:37 a. m...	703.3	9.3	81	NW.	16.1	1,454	629.0	9.6	....	W.	....
10:55 a. m...	703.2	8.5	82	WNW.	14.8	954	667.6	12.6	....	W.	....
11:08 a. m...	703.3	8.4	82	NW.	16.1	893	672.6	8.7	....	WNW.	....
11:21 a. m...	703.5	8.4	82	WNW.	18.3	836	677.5	5.1	....	NW.	....
11:25 a. m...	703.6	7.8	88	NW.	20.1	526	703.6	7.8	88	NW.	20.1

Three kites were used; lifting surface, 18.9 sq. m. Wire out, 3,500 m., at maximum altitude.

Dense st. moving generally from the west-southwest covered the sky. Distant thunder was heard at 9:04 a. m. Rain fell from 9:27 to 10:15, and from 10:51 to 11:35 a. m. The head kite was obscured by clouds from 9:10 to 9:16, and at intervals from 9:49 to 10:35 a. m.

A low was central over Lake Superior, and a second depression lay over this station. Pressure was high over Texas and relatively high over New Brunswick.

RESULTS OF KITE FLIGHTS.

[May 3, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
7:19 a. m...	718.2	7.7	34	SSE.	4.9	526	718.2	7.7	34	SSE.	4.9.
7:25 a. m...	718.2	7.9	33	SSE.	5.4	880	687.4	8.1	....	SSE.	....
7:43 a. m...	718.2	8.6	33	S.	5.8	1,251	657.6	5.5	....	SSW.	....
8:17 a. m...	718.0	9.1	31	S.	6.3	1,845	611.1	1.4	....	SW.	....
8:31 a. m...	717.9	9.3	33	S.	6.7	2,222	582.9	−1.2	....	SW.	....
9:05 a. m...	717.7	9.9	33	S.	8.0	2,792	542.4	−5.1	....	SW.	....
10:47 a. m...	716.9	14.1	31	S.	7.6	2,448	567.2	−2.1	....	SW.	....
11:36 a. m...	716.3	15.8	28	S.	8.9	2,022	597.8	0.6	....	SW.	....
11:59 a. m...	715.9	15.6	29	S.	8.9	1,603	628.8	4.4	....	SSW.	....
12:24 p. m...	715.5	15.8	28	S.	9.8	1,152	664.2	8.8	....	S.	....
12:40 p. m...	715.3	16.7	25	S.	9.8	864	687.4	12.3	....	SSE.	....
1:00 p. m...	715.0	16.8	25	SE.	9.8	526	715.0	16.8	25	SE.	9.8

Three kites were used; lifting surface, 18.9 sq. m. Wire out, 6,500 m.; at the maximum altitude, 6,250 m.

At the beginning a few ci.-st. and a few st.-cu. moving from the southwest. The higher clouds increased to 4/10 by 8:53 a. m., and decreased to a few by the end of the flight. The lower clouds disappeared by 8:17 a. m., but began to form again at 10:29 a. m., and increased to 3/10 by the end.

Low pressure was central north of the upper Lakes and pressure was high over the middle Atlantic coast.

RESULTS OF KITE FLIGHTS.

[May 4, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
4:31 p. m....	712.8	13.8	33	SSE.	4.5	526	712.8	13.8	33	SSE.	4.5
4:19 p. m....	712.6	13.6	28	SSE.	3.1	912	680.6	9.8	....	S.	....
5:02 p. m....	712.5	13.3	29	SSE.	4.0	1,414	640.3	5.5	....	SSW.	....
5:25 p. m....	712.4	13.3	30	SSE.	3.6	1,803	610.2	1.8	....	SSW.	....
5:40 p. m....	712.4	13.3	30	S.	4.0	2,391	566.9	−4.0	....	WSW.	....
6:01 p. m....	712.3	13.4	31	S.	3.6	2,838	535.5	−6.6	....	WSW.	....
6:20 p. m....	712.2	13.4	32	S.	3.1	2,526	557.0	−5.6	....	WSW.	....
6:40 p. m....	712.2	13.6	32	S.	2.7	1,856	605.9	0.2	....	SW.	....
6:56 p. m....	712.1	13.2	35	S.	3.1	1,343	645.3	4.9	....	SW.	....
7:08 p. m....	712.1	13.1	34	SW.	2.7	864	683.9	9.1	....	SW.	....
7:13 p. m....	712.1	13.0	35	SW.	2.7	526	712.1	13.0	35	SW.	2.7

Four kites were used; lifting surface, 30.6 sq. m. Wire out, 4,000 m.; at maximum altitude, 3,700 m.

A few ci.-st. moving from the west-southwest and 1/10 st.-cu. moving from the west-northwest at the beginning. At 5:30 p. m. 3/10 st.-cu. moving from the west. Clouds then increased to 8/10 st.-cu. by 6:30 p. m. St. moving from the west covered the sky at the end. Light rain fell at intervals from 7:12 to 7:30 p. m.

Pressure was relatively high over the Middle and South Atlantic States, and was low over Missouri. Slight depressions lay over eastern North Carolina and southern Florida.

RESULTS OF KITE FLIGHTS.

[May 5, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
8:10 a. m...	712.1	10.6	60	W.	4.9	526	712.1	10.6	60	W.	4.9
8:57 a. m...	712.2	13.4	56	W.	4.9	985	674.4	11.0	....	W.	....
9:30 a. m...	712.4	14.4	60	WSW.	4.5	1,532	631.8	7.9	....	WSW.	....
10:06 a. m...	712.5	16.3	48	WNW.	5.4	1,188	658.7	10.3	....	W.	....
10:19 a. m...	712.6	16.0	46	W.	5.4	526	712.6	16.0	46	W.	5.4

Three kites were used; lifting surface, 19.4 sq. m. Wire out, 1,800 m., at maximum altitude.

From 3/10 to 7/10 a. cu. moving from the west.

High pressure was central over Florida and low over Wisconsin.

RESULTS OF KITE FLIGHTS.

[May 6, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
1:00 p. m....	714.6	26.4	30	S.	5.4	526	714.6	26.4	30	S.	5.4
2:51 p. m....	713.8	27.1	27	S.	4.5	948	680.3	22.1	....	S.	....
3:49 p. m....	713.5	26.8	23	S.	4.9	1,268	655.4	19.2	....	S.	....
4:38 p. m....	713.4	27.2	30	SE.	4.5	1,797	616.2	14.0	....	SSW.	....
4:55 p. m....	713.4	27.0	28	SE.	4.5	2,303	580.2	9.4	....	SSW.	....
5:02 p. m....	713.4	26.7	23	SSE.	4.0	2,751	549.5	4.8	....	SSW.	....
5:15 p. m....	713.4	26.6	29	SSE.	3.1	2,737	549.5	1.8	....	SW.	....
5:25 p. m....	713.4	26.7	29	SSE.	3.6	2,287	580.2	5.1	....	SW.	....
5:34 p. m....	713.3	26.7	27	SSE.	3.1	1,788	616.2	11.1	....	SW.	....
5:43 p. m....	713.3	26.7	25	SSE.	3.6	1,292	653.2	16.4	....	SSW.	....
5:51 p. m....	713.3	26.8	25	SSE.	3.6	999	675.8	20.2	....	S.	....
6:50 p. m....	713.3	26.4	23	S.	4.5	526	713.3	26.4	23	S.	4.5

Eight kites were used; lifting surface, 51.9 sq. m. Wire out, 5,500 m.; at the maximum altitude, 4,900 m.

5/10 to 8/10 ci.-st. and from 2/10 to 5/10 cu., the former decreasing and the latter increasing during the flight. Both were moving from the west, but the cu. were fairly low, apparently being about 3,000 m. above sea level.

At 8 a. m. pressure was moderately high over the South Atlantic States, and low over Texas, the upper Lake region and the St. Lawrence Valley.

RESULTS OF KITE FLIGHTS.

[May 7, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
7:18 a. m....	714.4	18.8	41	WNW.	8.9	526	714.4	18.8	41	WNW.	8.9
7:31 a. m....	714.5	18.9	42	WNW.	8.0	907	683.6	18.1	....	NW.	....
7:45 a. m....	714.6	19.4	42	WNW.	6.7	1,050	672.4	18.0	....	WNW.	....
8:18 a. m....	714.7	20.4	45	WNW.	5.8	1,639	628.0	16.0	....	W.	....
8:45 a. m....	714.8	21.7	39	WNW.	5.4	2,017	600.6	12.6	....	WSW.	....
9:14 a. m....	714.8	22.2	39	NW.	3.1	2,378	574.8	7.8	....	WSW.	....
9:33 a. m....	714.8	22.5	38	WSW.	3.1	1,869	611.1	12.0	....	WSW.	....
9:46 a. m....	714.8	22.9	36	W.	3.6	1,293	654.2	18.0	....	W.	....
9:58 a. m....	714.8	23.1	36	W.	2.7	526	714.8	23.1	36	W.	2.7

Five kites were used; lifting surface, 32.0 sq. m. Wire out, 3,600 m., at maximum altitude.

Ci.-st. moving from the west-southwest decreased gradually from 9/10 at the beginning to 2/10 at the end of the flight.

A shallow depression extended from the Lakes to this station. Pressure was high over Maine and Illinois.

RESULTS OF KITE FLIGHTS.

[May 8, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
12:11 p. m ..	716.5	18.6	69	SE.	4.9	526	716.5	18.6	69	SE.	4.9
2:23 p. m...	715.5	20.8	65	SE.	5.4	1,172	663.9	17.2	....	SSE.	....
2:35 p. m...	715.4	21.0	63	SE.	5.4	1,724	621.8	12.3	....	S.	....
3:09 p. m...	715.1	21.0	59	SE.	4.9	2,160	589.9	8.2	....	SSW.	....
3:35 p. m...	715.3	21.4	63	SE.	4.0	2,729	551.0	5.2	....	SW.	....
3:46 p. m...	715.4	22.0	61	SE.	4.5	2,464	568.5	3.6	....	SW.	....
3:54 p. m...	715.5	22.2	60	SE.	3.6	2,096	594.3	5.2	....	SW.	....
4:03 p. m...	715.5	22.0	59	SE.	4.0	1,492	639.3	12.7	....	SSW.	....
4:12 p. m...	715.5	21.3	61	SE.	3.6	942	681.9	16.2	....	SSE.	....
4:25 p. m...	715.6	21.3	63	SE.	3.6	526	715.6	21.3	63	SE.	3.6

Six kites were used; lifting surface, 40.3 sq. m. Wire out, 4,400 m.; at maximum altitude, 3,300 m.

About 2/10 st. moving from the southeast until 3:10 p. m. From 2/10 to 4/10 cu. from the south after 3 p. m. Clouds passed below the head kite at intervals from 2:54 to 3:35 p. m.

A trough of low pressure extended from Lake Superior to Texas. High pressure was central over eastern New York.

RESULTS OF KITE FLIGHTS.

[May 10, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
7:12 a. m.	710.2	14.7	92	SSW.	6.3	526	710.2	14.7	92	SSW.	6.3
7:18 a. m.	710 2	14.7	95	SSW.	8.9	871	680.9	11.8	....	SW.	....
8:01 a. m.	710.2	14.3	95	W.	3.6	1,508	631.6	8.6	....	SW.	....
9:07 a. m.	709.9	16.1	83	S.	2.7	2,040	592.7	4.2	....	SW.	....
9:51 a. m.	709.9	16.3	84	SE.	3.6	1,571	627.1	9.9	....	S.	....
10:07 a. m.	709 9	16.2	84	SE.	4.0	769	689.8	14.1	....	SSW.	....
10:19 a. m.	709.9	17.0	86	S.	4.0	526	709.9	17.0	86	S.	4.0

Four kites were used; lifting surface, 25.2 sq. m. Wire out, 3,250 m.; at maximum altitude, 3,100 m.

The sky was overcast with st. moving from the south-southwest. Light fog from 7:46 to 8:05 a. m., and light rain fell at intervals during the flight.

Pressure was low over the western portions of New York and Pennsylvania and a ridge of high pressure extended from Minnesota to Texas.

RESULTS OF KITE FLIGHTS.

[May 11, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
1:59 p. m.	715.5	15.1	32	WNW.	9.8	526	715.5	15.1	32	WNW.	9.8
2:23 p. m.	715 6	14.9	30	NW.	9.4	1,293	652.8	6.4	....	NW.	....
2:40 p. m.	715 7	15 0	32	NW.	11.2	1,681	622.5	1.7	....	NW.	....
2:54 p. m.	715 8	15.0	28	NW.	10.7	2,229	582 2	−1.0	....	NW.	....
3:02 p. m.	715.8	15 2	28	NW.	10.7	2,447	566.9	0.5	....	NW.	....
3:20 p. m.	715.8	15.6	29	NW.	10.7	3,119	520.9	−0.5	....	NNW.	....
3:30 p. m.	715 8	16.0	29	NW.	9.4	3,649	486.9	−4.3	....	N.	....
4:00 p. m.	715.8	15.6	32	NW.	12.5	3,828	476.0	−6.7	....	N.	....
4:22 p. m.	715.8	16.1	29	NW.	12.1	3,555	493.5	−4.5	....	NNW.	....
4:47 p. m.	715.8	15 7	27	NW.	11.2	2,796	542.8	1.3	....	NNW.	....
5:03 p. m.	715 8	15.4	27	NW.	11.6	2,167	586.6	2.1	....	NW.	....
5:15 p. m.	715 8	15.6	28	NW.	9.8	1,877	608 0	1.0	....	NW.	....
5:25 p. m.	715.9	15.4	26	NW.	8.9	1,378	646.3	5.1	....	NW.	....
5:40 p. m.	715.9	15.2	28	NW.	11.2	960	679.9	9.5	....	NW.	....
5:45 p. m.	716.0	15.2	28	NW.	8.9	526	716.0	15.2	28	NW.	8.9

Four kites were used; lifting surface, 25.2 sq. m. Wire out, 6,400 m.; at maximum altitude, 6,000 m.

The sky was cloudless.

A ridge of high pressure extended from Lake Michigan southwestward. Lows were central over southern Florida and New Hampshire.

RESULTS OF KITE FLIGHTS.

[May 12, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
7:35 p. m.	720.7	13.5	43	ESE.	3.6	526	720.7	13.5	43	ESE.	3.6
7:40 p. m.	720.8	13.0	47	ESE.	4.0	816	696.2	12.2	....	SSE.	....
8:04 p. m.	720.8	13.8	42	ESE.	3.6	1,093	673.8	11.5	....	SSW.	....
8:12 p. m.	720.9	14.2	42	SE.	3.0	873	691.7	12.0	....	S.	....
8:21 p. m.	720.9	13.9	41	SE.	3.1	526	720.9	13.9	41	SE.	3.1

One kite was used; lifting surface, 11.2 sq. m. Wire out, 1,000 m., at maximum altitude.

A few ci. in the northwest.

An extensive area of high pressure was central over West Virginia and pressure was low over Newfoundland.

RESULTS OF KITE FLIGHTS.

[May 13, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
7:22 a. m.	719.8	14.9	44	W.	4.5	526	719.8	14.9	44	W.	4.5
7:55 a. m.	719.7	15.8	46	WSW.	7.2	760	700.3	18.2	....	W.	....
8:04 a. m.	719.7	15.8	45	WSW.	7.6	1,524	640.2	12.9	....	WNW.	....
8:15 a. m.	719.7	16.9	44	WSW.	5.8	1,839	616.6	10.0	....	WNW.	....
9:28 a. m.	719.6	19.0	38	WSW.	5.4	2,182	591.3	8.0	....	WNW.	....
10:01 a. m.	719.5	20.4	42	W.	4.5	2,694	556.3	5.5	....	W.	....
10:21 a. m.	719.3	20.6	38	WSW.	4.0	2,178	591.3	6.3	....	WNW.	....
10:40 a. m.	719.2	21.2	39	W.	4.0	1,739	623.3	8.1	....	WNW.	....
10:52 a. m.	719.0	21.3	39	WSW.	3.6	1,374	651.0	12.0	....	WNW.	....
10:59 a. m.	719.0	21.4	37	WSW.	2.7	893	689.1	17.5	....	W.	....
11:06 a. m.	719.0	21.8	35	SW.	2.7	526	719.0	21.8	35	SW.	2.7

Six kites were used; lifting surface, 38.8 sq. m. Wire out, 4,300 m.; at the maximum altitude, 3,700 m.

Light haze. 5/10 to 8/10 ci.-st., the latter moving from the west. A faint solar halo.

Pressure was high over the Atlantic coast States and low over Lake Superior and Kansas.

RESULTS OF KITE FLIGHTS.

[May 14, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
7:12 a. m...	717.2	19.8	48	WSW.	4.9	526	717.2	19.8	48	WSW.	4.9
7:48 a. m...	717.2	19.5	54	WSW.	4.9	939	683.6	17.2	....	WNW.	....
8:10 a. m...	717.2	20.6	48	WSW.	5.4	1,514	638.8	11.5	....	WNW.	....
8:30 a. m...	717.2	21.2	47	WSW.	5.4	2,088	596.1	5.7	....	WNW.	....
8:50 a. m...	717.2	21.3	45	W.	5.8	2,713	552.8	2.5	....	WNW.	....
10:25 a. m...	716.9	22.2	41	W.	6.7	2,935	537.5	0.0	....	WNW.	....
11:46 a. m...	716.5	23.4	41	W.	4.5	3,382	509.0	—2.3	....	WNW.	....
12:45 p. m...	716.1	25.2	40	W.	8.0	4,044	468.5	—8.0	....	W.	....
1:53 p. m...	715.6	25.4	41	W.	6.3	3,447	504.6	—3.7	....	W.	....
2:08 p. m...	715.4	25.2	40	W.	6.7	2,970	535.3	0.4	....	W.	....
2:26 p. m...	715.3	24.2	37	W.	6.3	1,869	611.1	7.8	....	W.	....
2:34 p. m...	715.2	24.2	36	W.	5.8	1,237	658.7	14.7	....	W.	....
2:48 p. m...	715.1	25.8	35	W.	5.8	526	715.1	25.8	35	W.	5.8

Seven kites were used; lifting surface, 45.1 sq. m. Wire out, 6,300 m., at maximum altitude.

About 8/10 ci.-st. at the beginning of the flight were gradually replaced by a.-cu. after 8 a. m. and the a.-cu. by st.-cu. after 1:30 p. m., all clouds moving from the west. The head kite was in st.-cu. clouds from 1:30 to 1:41 p. m.

High pressure was central over the south Atlantic coast and low over Ontario.

RESULTS OF KITE FLIGHTS.

[May 15, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
7:08 a. m...	714.7	19.6	61	W.	5.8	526	714.7	19.6	61	W.	5.8
7:19 a. m...	714.7	19.7	60	W.	6.3	840	688.5	18.9	....	WNW.	....
7:43 a. m...	714.7	20.4	56	W.	6.3	1,338	650.2	15.1	....	NW.	....
8:03 a. m...	714.7	20.8	57	W.	5.8	2,124	592.0	8.5	....	NW.	....
9:32 a. m...	711.3	23.5	48	WSW.	4.9	3,007	533.4	6.4	....	W.	....
9:51 a. m...	714.1	24.3	46	WSW.	5.4	2,476	568.4	8.8	....	W.	....
10:03 a. m...	714.1	24.4	47	WSW.	5.4	1,748	619.5	12.2	....	WNW.	....
10:12 a. m...	714.1	24.4	47	WSW.	5.4	1,072	670.6	17.6	....	W.	....
10:21 a. m...	714.0	24.3	44	W.	4.5	526	714.0	24.3	44	W.	4.5

Eight kites were used; lifting surface, 53.4 sq. m. Wire out, 5,450 m.; at maximum altitude, 4,500 m.

At the beginning 5/10 ci.-st. and 5/10 a.-st. The a.-st. gradually diminished, disappearing by 8:15 a. m. The ci.-st. increased to 8/10 by 7:30 a. m., decreased to 1/10 by 9:30 a. m., and increased to 5/10 by the end of the flight. Solar halo.

Low pressure was central over Iowa. Relatively high pressure lay over Ontario and the south Atlantic coast.

RESULTS OF KITE FLIGHTS.

[May 17, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
7:14 a. m...	713.8	16.2	46	W.	6.7	526	713.8	16.2	46	W.	6.7
7:24 a. m...	713.8	16.2	46	W.	6.7	809	690.4	13.9	....	W.	....
7:39 a. m...	713.9	16.4	47	W.	7.6	1,287	652.2	9.2	....	W.	....
7:49 a. m...	713.9	17.0	42	W.	7.6	1,728	618.5	6.0	....	W.	....
7:55 a. m...	714.0	16.8	44	W.	7.6	1,854	609.1	10.1	....	WNW.	....
8:16 a. m...	714.0	17.3	48	W.	7.2	2,354	573.4	8.7	....	WNW.	....
8:47 a. m...	714.1	17.6	47	W.	6.7	3,181	519.0	4.3	....	WNW.	....
9:13 a. m...	714.1	17.6	47	W.	8.0	2,356	573.4	8.5	....	WNW.	....
9:36 a. m...	714.2	18.0	45	W.	7.2	2,347	574.2	2.9	....	WNW.	....
9:46 a. m...	714.2	18.4	45	W.	7.2	1,690	621.8	6.1	....	W.	....
9:52 a. m...	714.2	18.8	45	W.	7.6	1,167	662.2	10.4	....	W.	....
10:00 a. m...	714.2	18.8	44	W.	8.0	744	695.4	15.0	....	W.	....
10:07 a. m...	714.1	19.0	44	W.	6.7	526	714.1	19.0	44	W.	6.7

Four kites were used; lifting surface, 25.7 sq. m. Wire out, 6,300 m.; at maximum altitude, 5,400 m.

Cloudless until 8:13 a. m., then a few cu. from the west. These had increased to 2/10 by the end of the flight. The altitude of the clouds was 1,700 m.

Low pressure was central over Ontario with a secondary depression off the Massachusetts coast. A ridge of relatively high pressure extended from Tennessee northwestward into Canada.

RESULTS OF KITE FLIGHTS.

[May 18, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
7:39 a. m...	715.2	12.5	69	NNW.	4.0	526	715.2	12.5	69	NNW.	4.0
8:30 a. m...	715.2	12.9	60	N.	4.0	737	....	10.8	....	NNW.	....
9:13 a. m...	715.2	13.6	63	NW.	5.8	1,242	656.6	9.6	....	NW.	....
10:01 a. m...	715.2	14.8	58	NW.	5.8	1,755	617.4	7.1	....	WNW.	....
10:20 a. m...	715.2	15.2	53	WNW.	6.7	2,249	581.5	6.4	....	WNW.	....
10:50 a. m...	715.2	15.8	53	N.	8.0	3,086	524.6	0.8	....	NW.	....
11:08 a. m...	715.2	15.6	56	NW.	8.0	3,555	491.9	−1.6	....	WNW.	....
11:20 a. m...	715.2	16.1	55	WNW.	5.8	3,839	477.5	−3.5	....	WNW.	....
11:35 a. m...	715.1	16.4	52	NW.	6.7	526	715.1	16.4	52	NW.	6.7

Six kites were used; lifting surface, 40.3 sq. m. Wire out, 6,400 m., at maximum altitude.

Cloudless until 9:45 a. m., after which about 1/10 ci.-st. and cu., both from the northwest.

Pressure was high over the upper Lakes. A slight depression lay over the North Carolina coast and a deeper one over Texas.

RESULTS OF KITE FLIGHTS.

[May 19, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
1:32 p. m....	716.4	15.3	58	SE.	4.5	526	716.4	15.3	58	SE.	4.5
4:30 p. m....	715.8	16.6	64	SE.	4.0	986	677.9	10.0	....	SSE.	....
4:55 p. m....	715.8	16.6	64	ESE.	3.1	1,550	633.5	6.6	....	S.	....
5:33 p. m....	715.8	15.8	63	ESE.	3.1	1,720	620.5	5.6	....	SSW.	....
5:40 p. m....	715.8	15.8	63	ESE.	3.6	1,350	648.8	8.0	....	S.	....
5:48 p. m....	715.8	15.8	65	SE.	3.1	1,041	673.4	9.9	....	SE.	....
5:54 p. m....	715.8	15.8	64	SE.	3.6	793	693.6	12.9	....	SE.	....
6:00 p. m....	715.8	15.7	64	SE.	3.6	526	715.8	15.7	64	SE.	3.6

Five kites were used; lifting surface, 32.0 sq. m. Wire out, 3,000 m.; at maximum altitude, 1,600 m.

8/10 to 10/10 st. moving from the south. The head kite was in the clouds for a short interval at 4:55, from 5:16 to 5:21 and from 5:28 to 5:33 p. m.

Low pressure over the lower Mississippi Valley and high over the Gulf of St. Lawrence and Lake Superior.

RESULTS OF KITE FLIGHTS.

[May 20, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
8:35 a. m...	717.2	9.9	98	ESE.	10.7	526	717.2	9.9	98	ESE.	10.7
8:45 a. m...	717.3	10.0	98	ESE.	9.4	805	693.6	7.3	....	SE.	....
8:51 a. m...	717.3	10.0	98	ESE.	9.8	1,104	669.0	10.1	....	SE.	....
9:18 a. m...	717.3	9.9	98	ESE.	8.5	1,360	648.6	9.0	....	SE.	....
9:40 a. m...	717.4	10.0	94	ESE.	8.5	1,669	625.0	6.1	....	SE.	....
11:31 a. m...	717.4	10.5	90	ESE.	7.6	1,948	603.8	6.5	....	ESE.	....
11:40 a. m...	717.4	10.5	90	ESE.	8.9	1,640	626.8	7.4	....	ESE.	....
11:47 a. m...	717.4	10.6	88	ESE.	7.2	1,358	648.6	8.2	....	SE.	....
11:58 a. m...	717.4	11.0	85	ESE.	5.4	833	691.4	6.1	....	ESE.	....
12:06 p. m...	717.4	11.0	86	ESE.	5.4	526	717.4	11.0	86	ESE.	5.4

Five kites were used; lifting surface, 31.5 sq. m. Wire out, 6,000 m.; at the maximum altitude, 2,550 m.

The sky was overcast with low st. clouds from the southeast. At intervals during the early part of the flight there was a light fog from the east-southeast. Light rain fell from 9:51 a. m. to 9:58 a. m. and from 12:01 p. m. until the close of the flight.

Pressure was low over the Southern States and high over the St. Lawrence Valley and the Lake region.

RESULTS OF KITE FLIGHTS.

[May 21, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
1:37 p. m....	715.0	7.5	100	NE.	8.0	526	715.0	7.5	100	NE.	.0
1:48 p. m....	714.9	7.6	100	ENE.	10.3	1,058	670.2	5.9	....	ENE.	....
2:08 p. m....	714.8	7.6	100	ENE.	11.2	1,283	651.9	5.6	....	ENE.	....
2:14 p. m....	714.8	7.6	100	ENE.	10.7	1,717	618.2	4.2	....	ENE.	....
2:47 p. m....	714.5	7.6	100	ENE.	9.4	1,196	658.5	5.4	....	ENE.	....
2:53 p. m....	714.4	7.7	100	ENE.	9.4	526	714.4	7.7	100	ENE.	9.4

Two kites were used; lifting surface, 12.6 sq. m. Wire out, 1,900 m., at maximum altitude.

Very low st. moving from the east-northeast. Rain fell throughout the flight. Light fog until 2:14 p. m., dense fog thereafter.

Low pressure was central over South Carolina, high pressure over Maine.

RESULTS OF KITE FLIGHTS.

[May 22, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
9:59 a. m...	712.5	7.8	100	N.	5.4	526	712.5	7.8	100	N.	5.4
10:02 a. m...	712.5	7.8	100	N.	5.4	764	692.3	7.1	....	NE.	....
10:18 a. m...	712.5	8.2	100	N.	4.9	1,339	645.3	4.6	....	NE.	....
10:49 a. m...	712.3	8.3	100	N.	5.4	1,817	608.6	6.7	....	NE.	....
11:04 a. m...	712.3	8.4	100	N.	5.8	1,423	638.6	6.7	....	NE.	....
11:14 a. m...	712.3	8.7	100	NNE.	5.4	1,311	647.3	4.2	....	ENE.	....
11:25 a. m...	712.3	8.7	100	N.	5.4	923	678.9	5.7	....	NNE.	....
11:35 a. m...	712.3	8.7	100	N.	6.3	526	712.3	8.7	100	N.	6.3

Two kites were used; lifting surface, 12.6 sq. m. Wire out, 2,500 m., at maximum altitude.

Light rain, accompanied by dense fog, throughout the flight.

A low was central off the Carolina coast. High pressure prevailed over Lake Superior and the Gulf of St. Lawrence.

RESULTS OF KITE FLIGHTS.

[May 24, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
8:40 p. m....	715.9	14.7	55	N.	3.6	526	715.9	14.7	55	N.	3.6
9:13 p. m....	715.9	14.6	57	NE.	3.6	770	695.6	13.5	....	NE.	....
9:37 p. m....	716.0	14.6	57	NE.	3.6	526	716.0	14.6	57	NE.	3.6

One kite was used; lifting surface, 11.2 sq. m. Wire out, 440 m., at maximum altitude.

The sky was cloudless.

Pressure was high north of Lake Superior and over North Carolina. Low-pressure areas were central over Nova Scotia and Texas.

RESULTS OF KITE FLIGHTS.

[May 25, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
1:08 p. m....	718.1	19.6	51	SE.	2.7	526	718.1	19.6	51	SE.	2.7
3:05 p. m....	717.6	19.3	57	SE.	3.1	960	682.2	14.7	....	S.	....
3:30 p. m....	717.6	19.1	57	SE.	3.6	1,330	652.8	11.3	....	S.	....
3:46 p. m....	717.6	18.8	58	SSE.	3.6	1,636	629.2	8.1	....	S.	....
4:02 p. m....	717.6	18.4	63	SSE.	3.1	1,353	650.8	10.0	....	S.	....
4:13 p. m....	717.6	18.2	65	SSE.	3.6	1,069	673.2	12.0	....	S.	....
4:23 p. m....	717.6	18.2	65	SSE.	3.6	792	695.6	13.9	....	S.	....
4:31 p. m....	717.6	17.8	65	SSE.	3.6	526	717.6	17.8	65	SSE.	3.6

One kite was used; lifting surface, 11.2 sq. m. Wire out, 1,900 m.; at maximum altitude, 1,600 m.

7/10 to 8/10 a.-st. moving from the west and 2/10 cu. from the northwest.

Low pressure was central over Missouri and high pressure off the Carolina coast and over the upper Lakes.

RESULTS OF KITE FLIGHTS.

[May 26, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
5:01 p. m....	719.7	14.5	100	SE.	3.6	526	719.7	14.5	100	SE	3.6
5:16 p. m....	719.7	14.8	100	SE.	3.6	987	681.5	11.9	....	SSE.	....
5:56 p. m....	719.6	14.9	100	SE.	3.6	1,408	647.9	10.3	....	S.	....
6:05 p. m....	719.6	14.8	100	SE.	3.6	848	692.7	12.3	....	SSE.	....
6:14 p. m....	719.6	14.8	100	SE.	3.6	526	719.6	14.8	100	SE.	3.6

One kite was used; lifting surface, 11.2 sq. m. Wire out, 1,370 m.; at maximum altitude, 1,100 m.

Dense fog. Light rain began 5:16 p. m. and continued.

Areas of high pressure were central north of Lake Huron and over Connecticut. Low pressure was central over Iowa, with a secondary depression over Missouri.

RESULTS OF KITE FLIGHTS.

[May 27, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
10:51 a. m...	715.6	17.6	99	S.	4.5	526	715.6	17.6	99	S.	4.5
11:16 a. m...	715.4	18.1	99	S.	4.0	992	677.9	19.7	....	WSW.	....
11:44 a. m...	715.3	19.2	97	S.	4.5	1,603	631.2	13.5	....	W.	....
12:32 p. m...	714.9	20.6	87	S.	4.0	1,967	603.8	12.3	....	WSW.	....
12:46 p. m...	714.8	21.0	86	S.	3.6	2,364	575.8	9.5	....	WSW.	....
1:17 p. m...	714.5	22.2	86	S.	4.0	2,912	538.6	4.6	....	W.	....
1:43 p. m...	714.2	22.6	86	S.	3.1	3,354	510.2	1.9	....	W.	....
3:04 p. m...	713.2	24.0	77	S.	4.5	2,930	536.4	2.6	....	WSW.	....
3:27 p. m...	713.1	24.2	75	S.	4.5	2,537	562.7	5.6	....	WSW.	....
3:43 p. m...	713.0	24.4	76	S.	4.5	2,191	586.8	8.6	....	WSW.	....
3:58 p. m...	712.9	24.4	75	S.	5.4	1,776	616.5	12.4	....	SW.	....
4:08 p. m...	712.9	24.4	74	S.	4.9	1,403	644.3	16.4	....	SW.	....
4:20 p. m...	712.9	24.0	73	S.	6.3	879	684.6	20.5	....	S.	....
4:25 p. m...	712.8	24.0	73	S.	5.8	526	712.8	24.0	73	S.	5.8

Five kites were used; lifting surface, 33.5 sq. m. Wire out, 6,200 m., at the maximum altitude.

Dense fog until 10:15 a. m., after that light fog until 11:37 a. m. 2/10 to 6/10 ci.-st. and ci.-cu., moving from the west and from 2/10 to 6/10 cu., moving from the southwest, the average cloudiness being about 7/10. Solar halo. The top kite was frequently obscured by cumulus clouds; it emerged from them at 3:37 p. m., the altitude being about 2,300 m.

A low was central over the Lake region. Pressure was relatively high off the New England coast.

RESULTS OF KITE FLIGHTS.

[May 28, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
7:29 a. m.	713.2	17.2	73	WNW.	5.4	526	713.2	17.2	73	WNW.	5.4
7:38 a. m.	713.2	17.4	73	WNW.	5.4	852	686.5	14.3	....	WNW.	....
8:08 a. m.	713.2	18.0	75	WNW.	5.4	1,276	652.6	10.0	....	W.	....
8:27 a. m.	713.1	18.0	67	WNW.	4.0	1,872	607.3	5.3	....	W.	....
8:49 a. m.	713.0	18.2	68	WNW.	3.1	2,409	568.9	2.1	....	WNW.	....
9:18 a. m.	712.9	18.6	71	NW.	3.6	2,927	533.8	−1.0	....	W.	....
9:40 a. m.	712.8	18.6	72	W.	8.0	2,534	560.1	1.1	....	W.	....
10:05 a. m.	712.7	18.6	71	W.	8.0	2,590	555.7	−1.0	....	WNW.	....
10:20 a. m.	712.6	19.8	58	W.	8.0	2,343	573.2	1.0	....	W.	....
10:36 a. m.	712.6	20.0	55	W.	7.6	1,951	601.2	3.1	....	W.	....
10:46 a. m.	712.5	20.2	55	W.	8.0	1,781	613.9	5.4	....	W.	....
11:00 a. m.	712.5	20.2	52	W.	8.0	1,357	646.2	10.5	....	W.	....
11:16 a. m.	712.4	20.3	53	W.	7.2	873	684.2	15.4	....	W.	....
11:22 a. m.	712.3	20.4	53	W.	6.7	526	712.3	20.4	53	W.	6.7

Five kites were used; lifting surface, 32.0 sq. m. Wire out, 5,300 m.; at maximum altitude, 4,400 m.

2/10 to 6/10 a.-st. from the west-southwest until 8:50 a. m., cu. from the west in amounts from a few to 7/10 during the remainder of the flight. The head kite was in the clouds from 9:22 to 9:40, from 9:55 to 10:03, and at intervals from 10:14 to 10:36 a. m.

Low pressure was central over Ontario and high over Alabama and the Gulf of St. Lawrence.

RESULTS OF KITE FLIGHTS.

[May 29, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
7:21 a. m.	711.2	14.9	72	NW.	13.9	526	711.2	14.9	72	NW.	13.9
7:34 a. m.	711.2	15.2	69	WNW.	13.4	1,039	669.2	11.3	....	NW.	....
7:45 a. m.	711.2	15.2	67	WNW.	11.6	1,464	635.9	8.3	....	NW.	....
8:14 a. m.	711.3	15.9	64	WNW.	11.2	1,862	606.2	5.7	....	NNW.	....
8:41 a. m.	711.4	16.6	62	WNW.	11.6	2,161	584.8	3.7	....	NNW.	....
8:48 a. m.	711.4	16.6	62	WNW.	11.6	526	711.4	16.6	62	WNW.	11.6

Four kites were used; lifting surface, 18.2 sq. m. Wire out, 4,500 m., at maximum altitude.

St.-cu., from the northwest, diminished from 5/10 at the beginning to few at the end of the flight. Cu. began to form about 8:30 a. m.

Low pressure was central off the Maine coast. A ridge of relatively high pressure extended from Florida to Michigan.

RESULTS OF KITE FLIGHTS.

[May 31, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
8:50 a. m.	715.3	15.6	72	NNW.	5.4	526	715.3	15.6	72	NNW.	5.4
9:00 a. m.	715.3	15.6	72	NNW.	5.4	829	690.4	18.5	....	NW.	....
9:13 a. m.	715.3	15.4	80	NW.	4.9	1,252	657.2	16.0	....	NW.	....
9:31 a. m.	715.4	15.2	87	NW.	4.9	1,852	612.4	12.8	....	NW.	....
9:47 a. m.	715.5	15.2	89	NW.	5.4	2,548	563.5	8.4	....	NW.	....
10:09 a. m.	715.5	15.8	86	NW.	5.4	3,216	518.9	4.0	....	NW.	....
10:56 a. m.	715.5	16.8	84	WNW.	4.5	3,653	490.9	1.2	....	WNW.	....
11:12 a. m.	715.5	16.9	86	NW.	4.5	3,003	532.1	4.9	....	NW.	....
11:31 a. m.	715.5	17.4	84	NW.	4.5	2,464	568.5	8.2	....	NW.	....
11:41 a. m.	715.5	18.2	84	NW.	4.0	2,009	600.8	11.4	....	NW.	....
11:52 a. m.	715.5	18.4	84	NW.	4.9	1,254	657.2	15.8	....	NW.	....
12:02 p. m.	715.5	18.8	83	NW.	4.9	813	692.1	18.3	....	NW.	....
12:06 p. m.	715.5	18.8	83	NW.	4.9	526	715.5	18.8	83	NW.	4.9

Five kites were used; lifting surface, 32 sq. m. Wire out, 6,000 m.; at maximum altitude, 4,500 m.

At the beginning 10/10 a.-st. from the west. These had decreased to 9/10 by the end of the flight. Light rain fell from 8:57 to 9:54 a. m.

Low pressure was central over Iowa and Virginia. Pressure was relatively high north of Lake Huron and off the coast of Georgia.

RESULTS OF KITE FLIGHTS.

[June 1, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
1:22 p. m.	716.7	22.2	51	ESE.	6.3	526	716.7	22.2	51	ESE.	6.3
1:30 p. m.	716.7	22.4	53	ESE.	4.9	873	688.7	19.5	....	SE.	....
1:49 p. m.	716.5	22.4	54	ESE.	4.5	1,061	673.7	18.8	....	SSE.	....
3:21 p. m.	716.6	21.5	60	E.	4.5	891	687.0	18.2	....	SSE.	....
3:24 p. m.	716.6	21.4	60	E.	4.5	526	716.6	21.4	60	E.	4.5

Four kites were used; lifting surface, 31.1 sq. m. Wire out, 2,550 m.; at maximum altitude, 1,100 m.

10/10 ci.-st. at the beginning, a.-st. by 4 p. m. from the northwest. Solar halo. Light rain fell from 3:03 until 3:45 p. m. Thunder at 3:35, last at 3:45 p. m.

Low pressure was central over New Brunswick. Pressure was relatively high north of the Lakes.

RESULTS OF KITE FLIGHTS.

[June 2, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.	Height.	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
7:12 a. m...	716.8	18.0	94	W.	2.7	526	716.8	18.0	94	W.	2.7
7:18 a. m...	717.0	18.2	94	W.	2.7	852	690.4	19.1	....	W.	....
7:47 a. m...	717.3	18.6	91	W.	4.5	1,343	652.2	17.3	....	WNW.	....
8:15 a. m...	717.4	19.2	89	W.	3.6	1,705	625.2	15.4	....	W.	....
8:36 a. m...	717.3	19.6	88	W.	4.5	2,088	597.4	13.1	....	W.	....
9:08 a. m...	717.3	20.1	85	W.	4.0	2,272	584.2	10.8	....	W.	....
10:38 a. m...	717.1	21.4	75	W.	4.5	2,646	558.5	8.0	....	W.	....
10:55 a. m...	717.0	21.8	78	W.	5.4	1,616	631.8	15.3	....	W.	....
11:14 a. m...	717.0	22.1	76	WNW.	5.4	1,214	662.2	18.2	....	WNW.	....
11:20 a. m...	717.0	22.4	76	WNW.	5.4	876	688.7	19.0	....	WNW.	....
11:25 a. m...	717.0	22.0	76	WNW.	5.8	526	717.0	22.0	76	WNW.	5.8

Five kites were used; lifting surface, 32.5 sq. m. Wire out, 3,700 m.; at maximum altitude, 2,800 m.

4/10 to 7/10 ci. from the west. Low st. from the west at an altitude of about 200 m. passed under the head kite at intervals from 7:35 to 10:45 a. m.

High pressure was central off the New England coast and relatively low pressure over Maryland and eastern Pennsylvania.

RESULTS OF CAPTIVE BALLOON ASCENSION.

[June 3, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.	Height.	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
3:59 p. m....	714.3	18.0	98	SE.	2.2	526	714.3	18.0	98	SE.	2.2
4:07 p. m....	714.3	18.0	98	SE.	2.7	1,752	618.7	14.5	....	SW.	....
4:13 p. m....	714.3	18.3	98	SE.	3.1	1,343	649.2	15.5	....	SSW.	....
4:19 p. m....	714.3	18.2	98	SE.	3.1	941	680.6	17.6	....	SSW.	....
5:15 p. m....	714.2	18.4	98	SE.	2.7	526	714.2	18.4	98	SE.	2.7

One balloon was used; capacity, 25.6 cu. m. Wire out, 1,880 m.

Overcast with dense, low nimbus clouds. The balloon entered the clouds almost immediately and was hidden from view above 700 m.

A low was central over the Gulf States and a high over the Lake region.

RESULTS OF KITE FLIGHTS.

[June 4, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.	Height.	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.
	mm.	*°C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	*°C.*	*p. ct.*		*m. p. s.*
3:07 p. m....	709.3	21.4	91	ESE.	3.6	526	709.3	21.4	91	ESE.	3.6
4:40 p. m....	708.6	20.9	99	ESE.	3.6	708	693.9	19.8	....	SE.	....
5:16 p. m....	709.1	20.6	100	E.	4.0	1,057	666.8	17.6	....	ESE.	....
5:22 p. m....	708.5	20.6	100	E.	4.0	733	691.7	18.8	....	ESE.	....
5:29 p. m....	708.5	20.6	100	ESE.	4.9	526	708.5	20.6	100	ESE.	4.9

Two kites were used; lifting surface, 17.5 sq. m. Wire out, 1,280 m.; at maximum altitude, 700 m.

10/10 st. from the east-southeast until 3.45 p. m., from the southeast thereafter. Light rain fell after 4:20 p. m. Fog was dense at intervals after 5 p. m. The head kite was obscured by clouds when 100 m. above the surface, and was in clouds at intervals thereafter.

Centers of low pressure lay over Ohio and over western Virginia. Pressure was relatively high over the New England coast.

RESULTS OF KITE FLIGHTS.

[June 5, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.	Height.	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.
	mm.	*°C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	*°C.*	*p. ct.*		*m. p. s.*
8:25 a. m...	709.1	17.3	95	WNW.	7.6	526	709.1	17.3	95	WNW.	7.6
8:30 a. m...	709.1	17.3	95	WNW.	7.2	888	679.8	16.9	....	NNW.	....
8:47 a. m...	709.3	18.6	96	WNW.	6.7	1,354	644.0	16.2	....	NNW.	....
9:04 a. m...	709.4	19.2	91	WNW.	5.8	1,760	614.0	14.1	....	NNW.	....
9:20 a. m...	709.5	19.4	86	WNW.	6.7	2,148	586.4	11.5	....	NW.	....
9:49 a. m...	709.7	19.8	76	WNW.	6.3	2,272	577.6	9.2	....	WNW.	....
10:35 a. m...	709.8	20.9	79	NW.	6.7	2,244	579.8	8.9	....	NW.	....
11:07 a. m...	709.9	21.4	78	NW.	6.3	1,856	607.3	10.4	....	NNW.	....
11:17 a. m...	709.8	21.4	80	NW.	5.4	1,332	646.2	14.6	....	NW.	....
11:24 a. m...	709.8	21.2	79	NW.	5.4	758	691.0	18.0	....	NW.	....
11:31 a. m...	709.8	20.8	80	NW.	5.4	526	709.8	20.8	80	NW.	5.4

Six kites were used; lifting surface, 39.3 sq. m. Wire out, 5,500 m.; at maximum altitude, 3,800 m.

2/10 to 5/10 st.-cu. from the west-southwest. 1/10 to 3/10 low st. passed under the head kite at intervals from 8:53 to 9:17 a. m. Cu.-nb., increasing from 1/10 to 5/10 after 11 moved in from the Shenandoah Valley. Rain began at 11:40 a. m.

Low pressure was central over Maryland and New Jersey and high over Maine and New Brunswick.

RESULTS OF CAPTIVE BALLOON ASCENSION.

[June 7, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
5:13 p. m....	717.6	19.5	72	ESE.	2.2	526	717.6	19.5	72	ESE.	2.2
5:22 p. m....	717.6	19.7	72	SE.	2.7	1,696	625.8	14.2	....	NW.	....
5:40 p. m....	717.6	19.2	74	ESE.	3.1	1,335	652.5	15.7	....	NW.	....
5:51 p. m....	717.6	19.2	72	E.	2.7	1,018	676.1	17.7	....	O	....
5:54 p. m....	717.6	19.2	72	E.	2.7	526	717.6	19.2	72	E.	2.7

One balloon was used; capacity, 25.6 cu. m. Wire out, 2,100 m.

Light rain during the ascension. Thunderstorms occurred about 10 miles from the station on both east and west sides.

Areas of high pressure were over central Canada and North Carolina. Low pressure areas were central over Nevada and Kansas.

RESULTS OF KITE FLIGHTS.

[June 8, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
8:39 a. m...	719.8	12.8	100	E.	4.5	526	719.8	12.8	100	E.	4.5
11:16 a. m...	719.8	12.9	100	E.	5.4	862	691.6	12.0	....	E.	....
11:24 a. m...	719.7	13.0	100	E.	4.9	1,296	656.8	13.0	....	E.	....
11:26 a. m...	719.7	13.0	100	E.	4.9	862	691.6	12.0	....	E.	....
11:30 a. m...	719.7	13.0	100	E.	4.9	526	719.7	13.0	100	E.	4.9

Five kites were used; lifting surface, 32.0 sq. m. Wire out, 2,800 m.; at maximum altitude, 1,600 m.

The sky was obscured by dense fog after 9:27 a. m. Light rain fell throughout the flight. The head kite entered st. clouds at an altitude of 625 m.

High pressure prevailed over South Carolina and the upper Lakes, and relatively low pressure over Missouri.

RESULTS OF KITE FLIGHTS.

[June 9, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
1:36 p.m....	717.6	15.0	100	SE.	4.5	526	717.6	15.0	100	SE.	4.5
1:58 p.m....	717.5	14.9	100	SE.	5.4	786	695.9	16.7	....	S.	....
2:14 p.m....	717.4	14.8	100	SE.	3.6	526	717.4	14.8	100	SE.	3.6

One kite was used; lifting surface, 6.3 sq. m. Wire out, 600 m., at maximum altitude.

Light rain and dense fog.

Pressure was low over Texas, with depressions over Missouri and West Virginia. Pressure was relatively high over New England.

RESULTS OF KITE FLIGHTS.

[June 10, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
5:14 p.m....	714.5	18.2	96	WNW.	4.5	526	714.5	18.2	96	WNW.	4.5
5:21 p.m....	714.5	18.2	96	WNW.	3.6	1,199	660.5	16.6	....	WNW.	....
5:35 p.m....	714.6	18.2	96	WNW.	3.1	1,660	625.7	14.2	....	WNW.	....
5:50 p.m....	714.6	18.4	96	WNW.	2.2	2,154	589.7	10.3	....	WNW.	....
6:20 p.m....	714.6	18.6	94	W.	3.6	2,685	552.4	4.6	....	WNW.	....
6:51 p.m....	714.5	18.9	90	W.	4.5	3,282	513.0	0.0	....	WNW.	....
7:25 p.m....	714.5	18.6	93	W.	1.3	2,745	548.1	3.6	....	WNW.	....
7:42 p.m....	714.5	18.4	93	SSW.	1.8	2,271	580.9	7.6	....	WNW.	....
8:07 p.m....	714.5	18.5	93	SW.	2.2	1,507	636.5	12.1	....	WNW.	....
8:20 p.m....	714.5	18.7	93	SW.	4.0	1,052	671.9	15.7	....	WNW.	....
8:34 p.m....	714.5	18.5	94	SW.	4.0	526	714.5	18.5	94	SW.	4.0

Three kites were used; lifting surface, 23.8 sq. m. Wire out, 5,400 m.; at the maximum altitude, 5,200 m.

The wind, accompanied by dense fog, suddenly changed from south to west at 3:25 p. m., and a thunderstorm occurred from 3:32 to 4:05 p. m. At the beginning of the flight 5/10 ci.-st., ci.-cu., and a.-st., 4/10 st. and 1/10 cu. from the west-northwest. These had changed to 8/10 a.-st. at 7:15 p. m. The head kite was in the base of the clouds at intervals between 6:22 and 6:40 p. m. at an altitude of about 2,800 m.

At 8 a. m. low pressure was central over western Pennsylvania and high pressure over Maine and South Carolina.

RESULTS OF KITE FLIGHTS.

[June 11, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
8:34 a. m.	715.4	16.6	100	NNW.	4.5	526	715.4	16.6	100	NNW.	4.5
8:43 a. m.	715.4	16.6	100	NNW.	4.5	887	685.9	15.0	....	NNW.	....
8:50 a. m.	715.4	16.8	100	NNW.	4.9	928	682.6	15.0	....	NNW.	....
9:00 a. m.	715.4	17.4	100	NW.	5.4	1,242	657.7	13.8	....	NW.	....
9:18 a. m.	715.5	17.8	96	NW.	4.5	1,509	630.7	13.0	....	NW.	....
9:45 a. m.	715.5	17.6	96	NW.	4.0	1,782	617.3	13.2	....	NW.	....
10:08 a. m.	715.6	17.8	94	NW.	4.5	1,940	605.6	10.9	....	NW.	....
10:37 a. m.	715.7	17.0	96	NNW.	4.0	1,503	637.8	12.3	....	NNW.	....
10:46 a. m.	715.8	17.0	96	NNW.	4.0	1,098	669.3	13.6	....	NNW.	....
10:53 a. m.	715.8	17.0	96	NNW.	4.0	829	690.9	15.0	....	NNW.	....
10:58 a. m.	715.8	17.0	97	NNW.	4.5	526	715.8	17.0	97	NNW.	4.5

Three kites were used; lifting surface, 23.8 sq. m. Wire out, 2,700 m.; at maximum altitude, 2,500 m.

7/10 to 10/10 st. moving with the surface wind. 2/10 to 3/10 st.-cu. from the northwest after 9:15 a. m. Light fog from 8:38 to 8:57 a. m. Rain began at 10:58 a. m. The head kite was frequently hidden by low st. during the flight. From 9:45 to 10:16 a. m. it was in the upper clouds.

A low pressure was central over the Gulf of St. Lawrence. High pressure over the upper Mississippi and Missouri valleys.

RESULTS OF CAPTIVE BALLOON ASCENSION.

[June 12, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
10:41 a. m.	717.2	19.8	74	NW.	1.8	526	717.2	19.8	74	NW.	1.8
10:50 a. m.	717.2	21.0	69	NW.	1.8	1,480	641.8	15.0	....	SSW.	....
10:56 a. m.	717.2	21.0	69	NW.	1.8	1,942	607.4	10.7	....	WSW.	....
11:11 a. m.	717.2	20.7	69	NW.	0.9	1,655	628.4	12.1	....	SW.	....
11:29 a. m.	717.0	21.8	63	SW.	0.9	1,274	657.2	14.9	....	SSW.	....
11:38 a. m.	717.0	21.8	62	S.	1.8	916	685.4	17.8	....	S.	....
11:48 a. m.	716.9	22.2	61	S.	1.8	526	716.9	22.2	61	S.	1.8

One balloon was used; capacity, 25.6 cu. m. Wire out, 1,660 m.

About 6/10 ci.-st. from the west and cu. from the west-southwest. The balloon entered the base of the cu. at 10: 51 a. m., altitude 1,500 m., and was hidden by cu. at intervals until 11:19 a. m.

Pressure was low over the Gulf of St. Lawrence and was relatively high over the Middle Atlantic States.

RESULTS OF KITE FLIGHTS.

[June 14, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
7:10 a. m...	715.9	19.8	76	W.	7.2	526	715.9	19.8	76	W.	7.2
7:17 a. m...	715.9	20.1	75	W.	7.2	993	678.4	19.4	....	WNW.	....
7:33 a. m...	716.0	20.1	76	W.	7.6	1,562	634.7	16.2	....	WNW.	....
7:50 a. m...	716.0	20.6	75	W.	6.7	2,010	602.0	13.2	....	W.	....
8:08 a. m...	716.0	20.7	75	W.	5.8	2,329	579.6	11.2	....	W.	....
8:28 a. m...	716.1	20.9	75	W.	6.3	3,224	520.2	5.4	....	W.	....
9:02 a. m...	716.3	21.7	71	W.	8.5	3,845	482.2	1.4	....	WSW.	....
10:15 a. m...	716.3	22.8	68	W.	5.4	3,237	520.2	5.8	....	WSW.	....
11:05 a. m...	716.3	23.6	68	W.	4.5	2,682	556.5	9.2	....	W.	....
11:27 a. m...	716.3	24.4	66	SW.	4.9	2,144	593.7	13.3	....	W.	....
11:43 a. m...	716.3	24.2	67	W.	4.9	1,617	621.4	14.8	....	W.	....
11:54 a. m...	716.3	24.2	66	SW.	4.0	526	716.3	24.2	66	SW.	4.0

Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,500 m., at maximum altitude.

At the beginning 8/10 a.-st. from the southwest. These decreased to 6/10 at 9.01 a. m. At 9:50 a. m. ci.-st., 5/10 from the southwest.

Low pressure was central over the St. Lawrence Valley and high pressure was central over South Dakota.

RESULTS OF KITE FLIGHTS.

[June 15, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	°C.	p. ct.		m. p. s.	meters.	mm.	°C.	p. ct.		m. p. s.
8:33 a. m...	719.3	15.3	95	NNW.	4.5	526	719.3	15.3	95	NNW.	4.5
9:19 a. m...	719.5	15.4	96	NNW.	4.5	763	699.7	14.1	....	WNW.	....
9:44 a. m...	719.6	15.4	96	NNW.	5.4	927	686.4	16.4	....	WNW.	....
10:00 a. m...	719.7	15.8	93	NNW.	6.3	1,307	656.5	14.6	....	WNW.	....
11:13 a. m...	719.8	17.8	84	NW.	5.8	1,904	611.7	10.8	....	WNW.	....
12:10 p. m...	720.0	18.6	78	NW.	5.8	3,638	495.2	0.2	....	WNW.	....
12:27 p. m...	720.0	19.4	73	NW.	7.6	2,963	538.1	3.0	....	WNW.	....
12:56 p. m...	720.1	19.8	72	NW.	6.3	2,487	571.1	7.7	....	WNW.	....
1:15 p. m...	720.0	19.7	70	NW.	5.4	1,869	615.0	11.7	....	WNW.	....
1:30 p. m...	720.0	20.4	69	NW.	4.5	1,208	664.8	13.1	....	NW.	....
1:39 p. m...	720.0	20.8	69	NW.	5.4	732	703.0	16.6	....	NNW.	....
1:46 p. m...	719.9	20.8	69	NNW.	4.5	526	719.9	20.8	69	NNW.	4.5

Seven kites were used; lifting surface, 47.1 sq. m. Wire out, 5,500 m.; at maximum altitude, 4,400 m.

10/10 low st. from the north-northwest until 9:30 a. m. By 10 a. m. the cloud cover had risen above the kites and begun to break. At 10:45 a. m. 7/10 ci.-st. from the west and 3/10 st. from the northwest. St. again covered the sky from 11:20 a. m. until noon, after which it was gradually replaced by ci.-st. Solar halo. The head kite entered the base of the st. at 8:45 a. m., altitude 650 m., and was out of the clouds by 10 a. m.

An extensive area of high pressure was central over Illinois. Pressure was low over New Brunswick.

RESULTS OF KITE FLIGHTS.

[June 16, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	*°C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	*°C.*	*p. ct.*		*m. p. s.*
7:32 a. m...	722.2	16.0	79	ESE.	4.0	526	722.2	16.0	79	ESE.	4.0
11:13 a. m...	721.6	19.2	74	SE.	4.0	764	702.0	17.0	....	S.	....
12:04 p. m...	721.4	20.0	71	SE.	4.0	925	688.7	17.2	....	SSW.	....
12:15 p. m...	721.3	20.4	70	SSE.	3.6	1,175	668.8	15.5	....	SW.	....
12:30 p. m...	721.2	20.4	70	SSE.	3.6	1,790	621.8	11.8	....	SW.	....
1:05 p. m...	721.1	20.8	71	SE.	3.6	2,154	595.7	11.3	....	WSW.	....
1:23 p. m...	721.0	20.7	71	SE.	4.0	2,393	579.1	10.4	....	WSW.	....
2:49 p. m...	720.5	21.8	70	S.	3.6	2,896	545.3	8.6	....	WSW.	....
3:15 p. m...	720.3	21.7	71	S.	3.1	3,286	520.5	8.2	....	WSW.	....
3:30 p. m...	720.3	21.0	75	S.	4.0	2,714	556.8	9.2	....	WSW.	....
3:48 p. m...	720.2	21.0	75	S.	3.6	1,668	630.1	12.4	....	SW.	....
4:07 p. m...	720.1	20.8	75	S.	4.0	1,375	652.2	14.2	....	SSW.	....
4:26 p. m...	720.0	20.6	77	S.	4.5	888	690.4	16.5	....	S.	....
4:35 p. m...	719.9	20.5	79	SSE.	4.5	526	719.9	20.5	79	SSE.	4.5

Nine kites were used; lifting surface, 60.2 sq. m. Wire out, 5,500 m.; at maximum altitude, 4,000 m.

1/10 to 8/10 a.-cu. from the west until 10:30 a. m., and 2/10 to 8/10 st.-cu. thereafter moving from the south-southwest. The head kite was in the clouds at intervals after 12:26 a. m., emerging at about 1,400 m. altitude.

High pressure was central over the Middle Atlantic States and low over North Dakota.

RESULTS OF KITE FLIGHTS.

[June 17, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	*°C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	*°C.*	*p. ct.*		*m. p. s.*
9:19 a. m....	715.9	17.3	100	S.	4.9	526	715.9	17.3	100	S.	4.9
9:36 a. m....	715.8	17.4	100	S.	5.4	892	686.1	20.6	....	SSW.	....
9:43 a. m....	715.8	17.4	100	S.	5.4	1,324	652.5	17.9	....	SW.	....
2:14 p. m....	712.6	21.9	88	SE.	5.8	1,678	624.1	15.9	....	SW.	....
2:33 p. m....	712.5	22.0	89	SE.	4.5	2,930	537.8	6.6	....	SW.	....
2:47 p. m....	712.5	21.8	87	SE.	5.4	3,507	501.5	2.6	....	SW.	....
3:20 p. m....	712.4	20.4	100	SE.	5.8	526	712.4	20.4	100	SE.	5.8

Six kites were used; lifting surface, 41.3 sq. m. Wire out, 5,500 m.; at the maximum altitude, 4,400 m.

Dense fog until 11:25 a. m.; thereafter light fog until 12:20 p. m. During remainder of flight the sky was overcast with st. clouds from the south. A thunderstorm at 3:10 p. m. passed directly over the station; it was accompanied by excessive precipitation.

At 8 a. m. a trough of low pressure extended from Ontario to the middle Mississippi Valley. Pressure was relatively high off the New England coast.

RESULTS OF KITE FLIGHTS.

[June 18, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	*°C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	*°C.*	*p. ct.*		*m. p. s.*
8:40 a. m...	715.9	14.4	62	NW.	12.5	526	715.9	14.4	62	NW.	12.5
8:49 a. m...	716.0	14.5	63	NW.	11.6	834	690.3	11.6	....	NW.	....
9:03 a. m...	716.0	14.9	63	NW.	12.5	1,266	655.5	8.2	....	NNW.	....
10:15 a. m...	716.4	16.0	53	NW.	10.7	1,955	604.0	6.6	....	NW.	....
10:31 a. m...	716.9	16.0	54	NW.	12.1	2,414	571.7	6.2	....	NNW.	....
10:47 a. m...	717.1	16.6	59	NW.	10.7	2,781	547.0	5.6	....	NW.	....
11:43 a. m...	717.4	16.7	45	NW.	9.8	3,110	525.5	1.4	....	NW.	....
12:24 p. m...	717.5	17.0	42	NW.	10.7	2,418	571.7	2.6	....	NNW.	....
12:37 p. m...	717.5	17.0	39	NW.	11.6	1,920	607.3	4.6	....	NNW.	....
12:47 p. m...	717.5	17.0	37	NW.	11.2	1,530	636.7	7.5	....	NW.	....
12:58 p. m...	717.5	17.2	37	NW.	11.6	1,184	663.8	10.2	....	NW.	....
1:08 p. m...	717.6	17.5	35	NW.	9.8	835	692.0	13.3	....	NW.	....
1:15 p. m...	717.7	17.6	39	NW.	10.7	526	717.7	17.6	39	NW.	10.7

Four kites were used; lifting surface, 21.7 sq. m. Wire out, 5,500 m.; at maximum altitude, 4,400 m.

A few cu. from the northwest, altitude about 2,000 m.

An extensive high was central over Wisconsin. Low pressure was central over Maine.

RESULTS OF KITE FLIGHTS.

[June 19, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	*°C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	*°C.*	*p. ct.*		*m. p. s.*
7:11 a. m....	721.6	12.2	56	NW.	6.7	526	721.6	12.2	56	NW.	6.7
7:17 a. m....	721.6	12.4	54	NW.	7.2	821	696.7	11.0	....	NW.	....
7:30 a. m....	721.6	12.5	54	NW.	5.8	1,293	658.5	11.0	....	NW.	....
8:02 a. m....	721.6	13.0	54	NW.	8.0	1,560	638.1	11.9	....	WNW.	....
8:17 a. m....	721.7	13.4	55	NW.	7.2	1,864	615.4	9.2	....	WNW.	....
8:25 a. m....	721.7	13.6	51	NW.	7.2	2,208	590.5	7.0	....	WNW.	....
8:56 a. m....	721.8	14.3	55	NW.	4.0	3,195	523.6	2.1	....	WNW.	....
9:14 a. m....	721.9	14.6	53	NW.	3.6	3,776	487.3	—1.0	....	WNW.	....
9:34 a. m....	722.0	15.4	53	NW.	3.6	1,363	653.6	9.9	....	NW.	....
9:36 a. m....	722.0	15.4	53	NW.	3.6	526	722.0	15.4	53	NW.	3.6

Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,800 m.; at maximum altitude, 5,500 m.

3/10 to 6/10 ci.-cu. from the west-northwest.

A low was central over the Gulf of St. Lawrence and a high over West Virginia.

RESULTS OF CAPTIVE BALLOON ASCENSION.

[June 21, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	*°C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	*°C.*	*p. ct.*		*m. p. s.*
1:16 p. m....	721.4	28.4	42	W.	2.7	526	721.4	28.4	42	W.	2.7
1:38 p. m....	721.2	28.9	47	SW.	2.7	2,069	604.2	15.1	....	SW.	....
1:56 p. m....	721.1	29.4	43	SE.	2.7	1,686	631.9	18.2	....	SW.	....
2:06 p. m....	721.1	29.0	49	SE.	2.2	1,392	653.6	20.9	....	SW.	....
2:22 p. m....	721.0	29.4	47	S.	2.2	995	683.9	24.4	....	S.	....
2:33 p. m....	720.9	29.6	50	S.	2.2	526	720.9	29.6	50	S.	2.2

One balloon was used; capacity, 31.1 cu. m. Wire out, 2,460 m.

A few ci. with no apparent motion and 1/10 cu. moving from the southwest during the ascension.

High pressure was central over North Carolina and pressure was low over the lower St. Lawrence.

RESULTS OF KITE FLIGHTS.

[June 22, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	*°C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	*°C.*	*p. ct.*		*m. p. s.*
7:14 a. m...	719.0	22.6	76	W.	4.9	526	719.0	22.6	76	W.	4.9
9:05 a. m...	718.9	24.4	74	SW.	2.7	757	700.2	22.7	....	SW.	....
9:27 a. m...	718.9	24.8	71	S.	3.1	946	685.3	21.8	....	SW.	....
9:44 a. m...	718.9	24.6	77	S.	2.2	1,201	665.4	19.8	....	SW:	....
9:57 a. m...	718.9	24.3	78	S.	2.2	881	690.3	21.6	....	SW.	....
10:06 a. m...	718.9	24.5	78	S.	2.2	526	718.9	24.5	78	S.	2.2

Three kites were used; lifting surface, 19.4 sq. m. Wire out, 1,500 m.; at maximum altitude, 900 m.

2/10 to 6/10 ci.-cu. from the west until 8:45 a. m. After 8:20 a. m., 4/10 to 8/10 st.-cu. from the west-southwest.

High pressure was central over the Carolinas and low over southern Manitoba.

RESULTS OF KITE FLIGHTS.

[June 23, 1909.]

Hour.	On Mount Weather, Va., 526 meters					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.	Height.	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
6:59 a. m...	717.0	21.2	83	W.	7.2	526	717.0	21.2	83	W.	7.2
7:05 a. m...	717.0	21.2	83	W.	6.3	898	686.9	20.8	....	NW.	....
7:17 a. m...	717.0	21.2	83	W.	6.3	1,373	650.0	17.9	....	NW.	....
7:27 a. m...	717.0	21.4	83	WNW.	7.2	1,804	618.3	16.8	....	NW.	....
7:42 a. m...	717.1	22.0	82	W.	6.8	2,316	582.3	14.2	....	NW.	....
10:20 a. m...	717.2	24.8	74	W.	5.4	2,930	541.9	10.2	....	WNW.	....
10:38 a. m...	717.1	25.2	70	W.	5.8	2,300	584.0	13.7	....	NW.	....
10:54 a. m...	717.0	25.2	67	W.	4.9	1,874	613.9	16.2	....	NW.	....
11:08 a. m...	717.0	25.7	64	W.	5.4	1,073	673.6	19.9	....	NW.	....
11:15 a. m...	716.9	25.8	65	W.	5.4	880	688.6	22.1	....	NW.	....
11:23 a. m...	716.9	26.0	70	W.	4.9	526	716.9	26.0	70	W.	4.9

Five kites were used; lifting surface, 32 sq. m. Wire out, 5,400 m.; at maximum altitude, 4,100 m.

A few ci. (direction not determined). Cu. from the northwest began to form at 9:06 a. m. and had increased to 3/10 by the end of the flight. The base of the cu. was about 1,440 m. above sea level.

High pressure was central over Georgia and low pressure over Manitoba.

RESULTS OF KITE FLIGHTS.

[June 24, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.	Height.	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.
	mm.	°*C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	°*C.*	*p. ct.*		*m. p. s.*
6:56 a. m...	714.8	21.0	88	W.	5.8	526	714.8	21.0	88	W.	5.8
7:20 a. m...	714.8	21.8	86	W.	5.8	1,115	667.9	19.1	....	NW.	....
8:16 a. m...	714.9	22.0	85	WNW.	6.7	1,700	624.2	17.4	....	WNW.	....
10:01 a. m...	715.0	23.4	76	NW.	8.5	2,330	579.9	13.8	....	NW.	....
11:01 a. m...	715.0	25.3	70	WNW.	6.7	2,845	546.1	11.1	....	WNW.	....
11:28 a. m...	714.9	25.1	70	WNW.	6.7	3,573	499.9	6.0	....	WNW.	....
12:33 p. m...	714.7	25.9	68	NNW.	4.0	4.078	470.2	3.2	....	WNW.	....
12:57 p. m...	714.6	26.4	70	NNW.	2.7	4,740	433.9	0.3	....	WNW.	....
1:43 p. m...	714.3	25.9	72	W.	2.2	5,607	391.0	−0.1	....	W.	....
1:53 p. m...	714.2	27.2	68	W.	2.2	5,359	402.6	−1.4	....	W.	....
2:11 p. m...	714.2	27.2	68	N.	1.8	4,298	458.6	4.0	....	W.	....
2:39 p. m...	714.1	26.1	73	NW.	2.2	3,222	521.4	8.6	....	WNW.	....
2:56 p. m...	714.0	25.9	72	NW.	1.3	2,295	581.6	12.2	....	NW.	....
3:07 p. m...	714.0	25.7	71	SW.	2.7	1,508	637.6	16.3	....	NW.	....
3:15 p. m...	714.0	26.7	65	SW.	3.6	526	714.0	26.7	65	SW.	3.6

Ten kites were used; lifting surface, 65.0 sq. m. Wire out, 10,000 m.; at the maximum altitude, 8,800 m.

8/10 to 10/10 st.-cu. from the west till 11 a. m. After that they gradually dissipated and were replaced by cu., also moving from the west and varying in amount from 2/10 to 6/10. Thunderstorms appeared in the west at 12:57, 1:53, and 2:31 p. m., but all passed south of the station. Rain fell from 1:23 to 1:32 and from 3:05 to 3:14 p. m. The head kite was in or above the clouds at altitudes greater than 2,000 m.

At 8 a. m. a low was central over Long Island Sound. Pressure was high over the Lake region.

RESULTS OF KITE FLIGHTS.

[June 25, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
	mm.	*°C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	*°C.*	*p. ct.*		*m. p. s.*
6:30 a. m.	715.3	22.4	78	W.	6.3	526	715.3	22.4	78	W.	6.3
6:46 a. m.	715.3	22.8	76	W.	5.8	829	691.0	23.1	....	NW.	....
8:17 a. m.	715.5	24.0	74	W.	4.9	1,260	657.8	20.5	....	NW.	....
9:54 a. m.	715.8	25.6	72	W.	5.4	1,652	629.1	18.0	....	WNW.	....
10:05 a. m.	715.8	26.0	71	W.	4.9	1,858	614.1	16.2	....	W.	....
10:13 a. m.	715.8	26.0	72	W.	4.9	1,494	640.8	19.0	....	W.	....
10:20 a. m.	715.8	26.1	72	W.	4.9	1,202	662.8	20.9	....	WNW.	....
10:30 a. m.	715.8	26.4	68	W.	4.5	1,008	677.7	22.0	....	WNW.	....
10:38 a. m.	715.9	26.7	68	W.	4.5	734	699.3	23.8	....	WNW.	....
10:43 a. m.	715.9	27.0	68	W.	4.5	526	715.9	27.0	68	W.	4.5

Eight kites were used; lifting surface, 52.4 sq. m. Wire out, 4,300 m.; at maximum altitude, 2,600 m.

2/10 to a few ci.-cu from the west.

High pressure was central over Alabama and low over the Gulf of St. Lawrence and north of Lake Superior.

RESULTS OF KITE FLIGHTS.

[June 26, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind.		Height.	Air pressure.	Air temperature.	Relative humidity.	Wind.	
				Direction.	Velocity.					Direction	Velocity.
	mm.	*°C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	*°C.*	*p. ct.*		*m. p. s.*
6:52 a. m.	717.2	21.4	89	NW.	4.9	526	717.2	21.4	89	NW.	4.9
7:02 a. m.	717.2	21.7	90	NW.	4.9	808	694.4	22.3	....	NW.	....
7:47 a. m.	717.4	22.8	81	WNW.	4.0	1,150	667.9	21.6	....	NNW.	....
8:20 a. m.	717.5	23.0	81	WNW.	4.5	1,647	630.8	18.6	....	NNW.	....
9:09 a. m.	717.7	23.6	82	WNW.	2.7	2,196	591.5	14.6	....	NNW.	....
9:32 a. m.	717.9	23.6	82	WNW.	2.7	1,624	632.5	17.2	....	NNW.	....
9:39 a. m.	718.0	24.1	82	W.	2.7	1,265	659.6	19.7	....	N.	....
9:49 a. m.	718.0	24.4	78	WNW.	3.1	526	718.0	24.4	78	WNW.	3.1

Five kites were used; lifting surface, 32.0 sq. m. Wire out, 3,000 m.; at maximum altitude, 2,700 m.

2/10 or less ci. from the west.

High pressure was central north of Lake Huron, low pressure over New Brunswick.

RESULTS OF CAPTIVE BALOON ASCENSION.

[June 28, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.	Height.	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.
	mm.	*°C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	*°C.*	*p. ct.*		*m. p. s.*
2:58 p. m....	716.0	27.0	77	N.	0.4	526	716.0	27.0	77	N.	0.4
3:10 p. m....	716.0	25.8	81	N.	2.7	2,045	601.1	15.8	....	W.	....
3:31 p. m....	715.9	25.3	76	N.	3.1	1,406	647.2	18.4	....	WSW.	....
3:44 p. m....	715.9	24.8	80	N.	3.6	1,160	665.8	20.2	....	WSW.	....
3:52 p. m....	715.9	24.1	85	NW.	3.6	882	687.4	22.1	....	WSW.	....
4:00 p. m....	715.9	23.2	90	NW.	8.9	526	715.9	23.2	90	NW.	8.9

One balloon was used; capacity, 31.1 cu. m. Wire out, 2,400 m.

Light rain during the flight. 8/10 cu.-n. and 2/10 ci. from the west.

Areas of high pressure were central north of Lake Superior and off the coast of South Carolina. Pressure was relatively low over the Gulf coast.

RESULTS OF CAPTIVE BALLOON ASCENSION.

[June 29, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.	Height.	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.
	mm.	*°C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	*°C.*	*p. ct.*		*m. p. s.*
4:13 p. m....	715.9	26.8	64	ENE.	3.6	526	715.9	26.8	64	ENE.	3.6
4:24 p. m....	715.9	27.2	69	E.	4.0	1,067	673.4	23.5	....	ENE.	....
4:43 p. m....	716.0	26.8	68	E.	4.0	526	716.0	26.8	68	E.	4.0

One balloon was used; capacity, 31.1 cu. m. Wire out, 1,400 m.

About 3/10 ci.-st. from the southwest and a few cu. from the northwest.

Low pressure was central over the New Brunswick coast, high pressure over Lake Huron.

RESULTS OF CAPTIVE BALLOON ASCENSION.

[June 30, 1909.]

Hour.	On Mount Weather, Va., 526 meters.					At different heights above sea.					
	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.	Height.	Air pressure.	Air temperature.	Relative humidity.	Wind. Direction.	Wind. Velocity.
	mm.	*°C.*	*p. ct.*		*m. p. s.*	*meters.*	*mm.*	*°C.*	*p. ct.*		*m. p. s.*
2:27 p. m....	717.0	27.0	57	SSE.	1.8	526	717.0	27.0	57	SSE.	1.8
2:43 p. m....	716.9	27.0	57	SE.	1.8	2,358	581.0	16.7	....	NW.	....
3:04 p. m....	716.8	27.2	55	E.	1.8	1,825	617.7	17.1	....	NW.	....
3:17 p. m....	716.7	27.3	57	SE.	1.8	1,550	637.8	18.9	....	NW.	....
3:28 p. m....	716.6	27.0	58	SE.	1.8	1,016	678.1	23.0	....	O	....
3:35 p. m....	716.6	27.4	57	SE.	2.2	526	716.6	27.4	57	SE.	2.2

One balloon was used; capacity, 31.1 cu. m. Wire out, 2,400 m.

The sky was cloudless.

Pressure was low over the Gulf, and centers of relatively high pressure were over New York and Wisconsin.

O

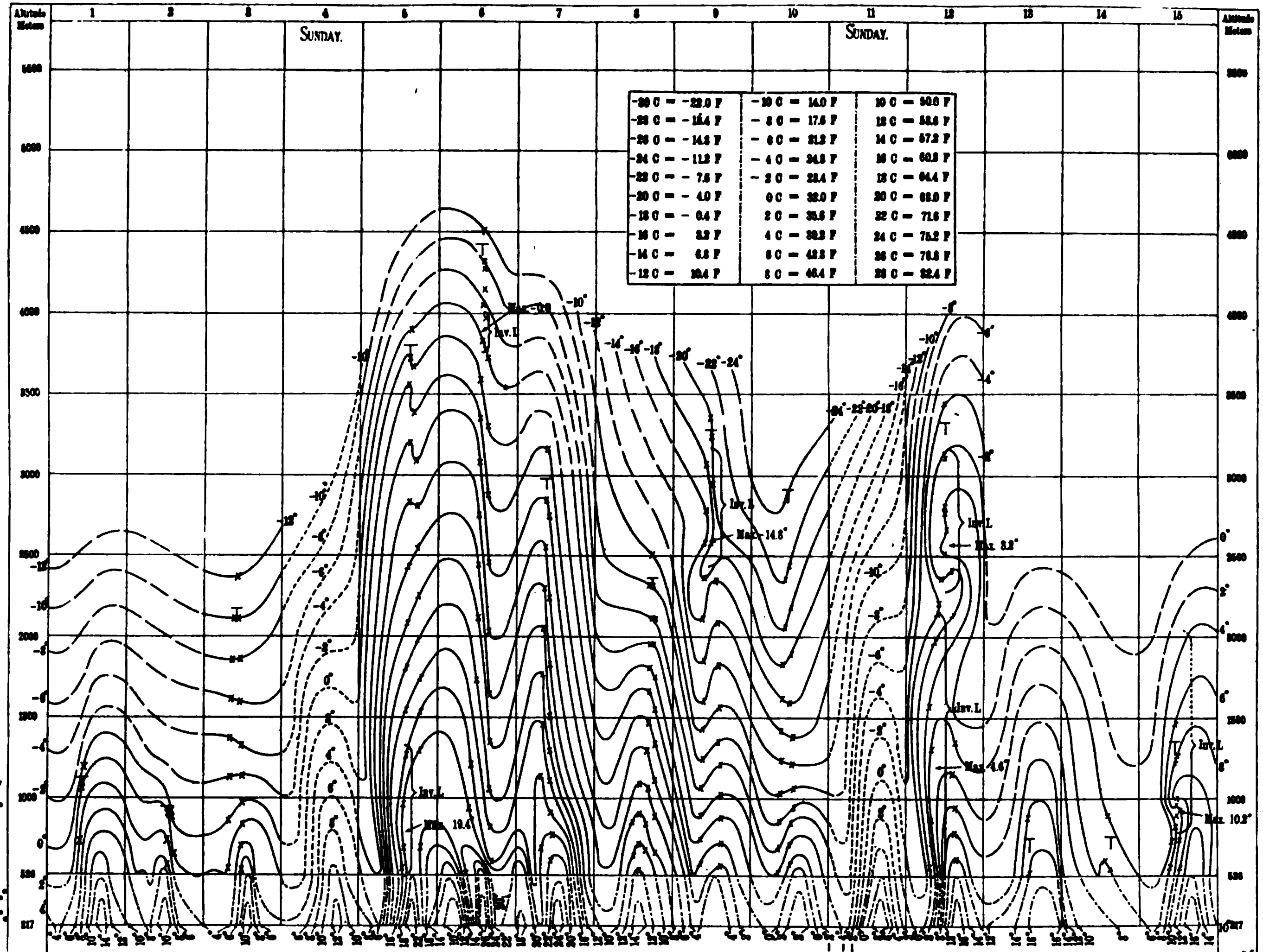
PHYSICAL LABORATORY (ON RIGHT); OFFICE AND COTTAGE BUILDING (ON LEFT).

CENTRAL HEATING AND POWER PLANT.

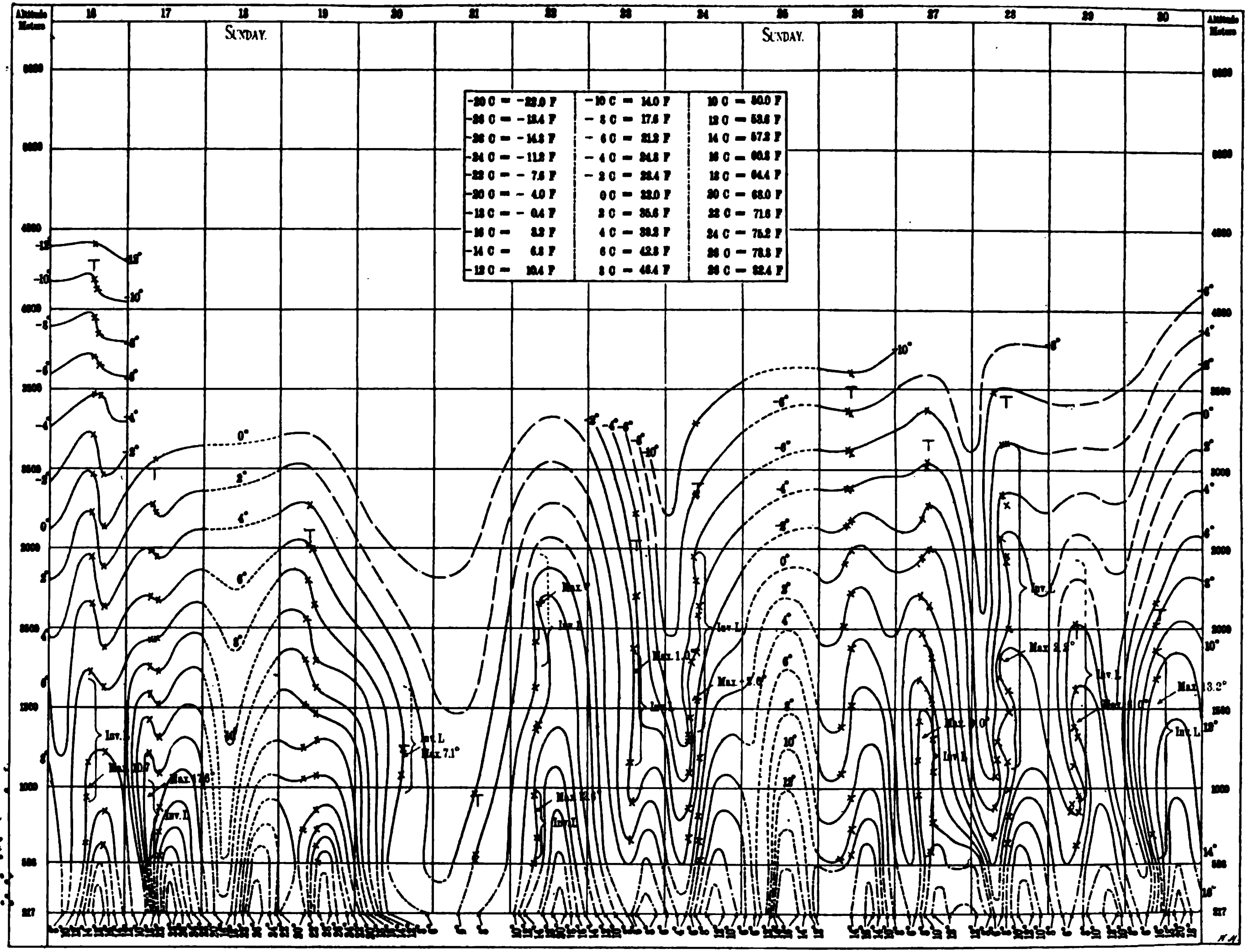
THE KITE REEL, SHOWING RIGHT-HAND SIDE AND FRONT.

THE KITE REEL, SHOWING RIGHT-HAND SIDE AND BACK.

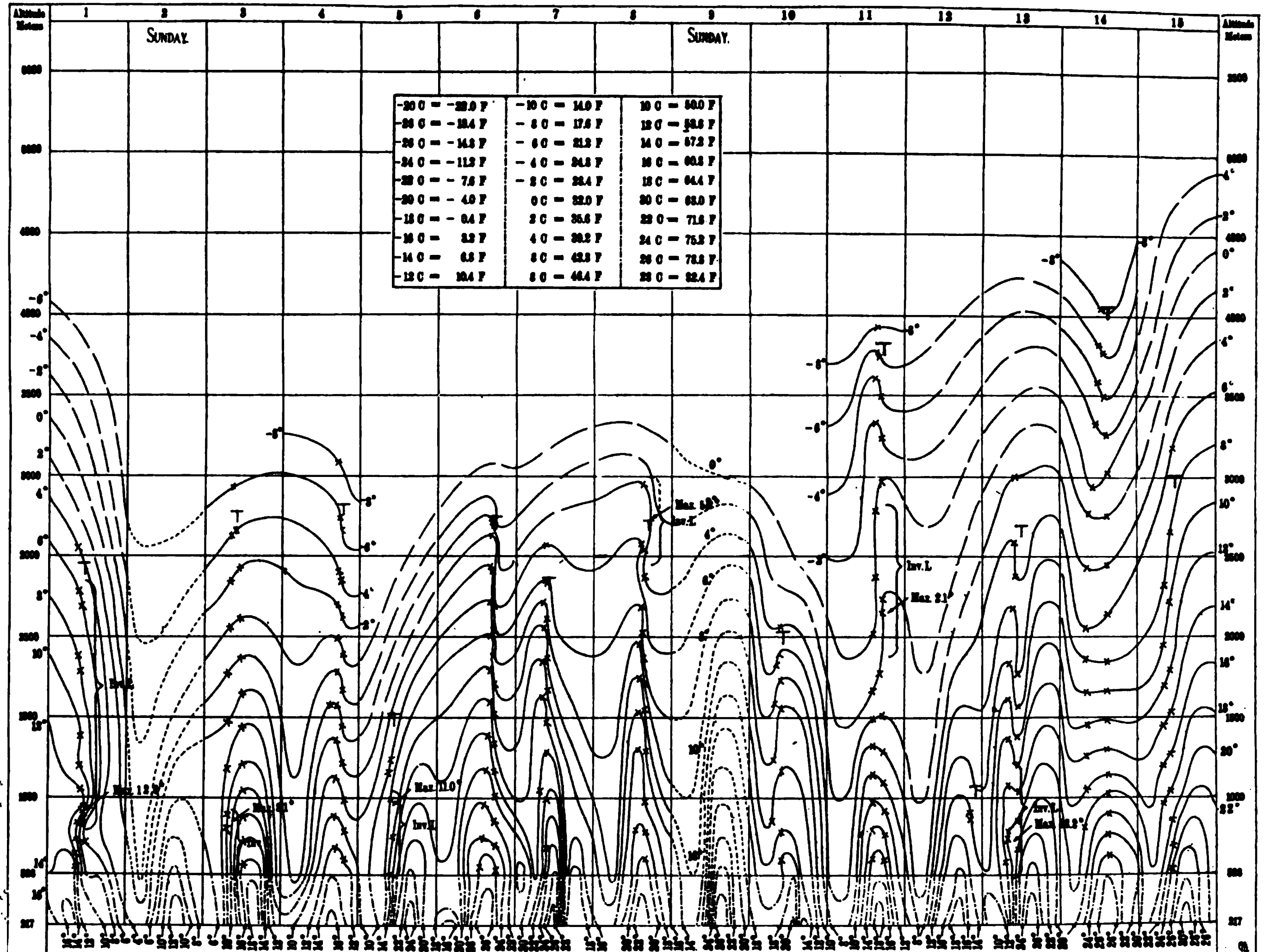
POSITION OF METEOROGRAPH ON KITE ABOUT TO BE LAUNCHED.



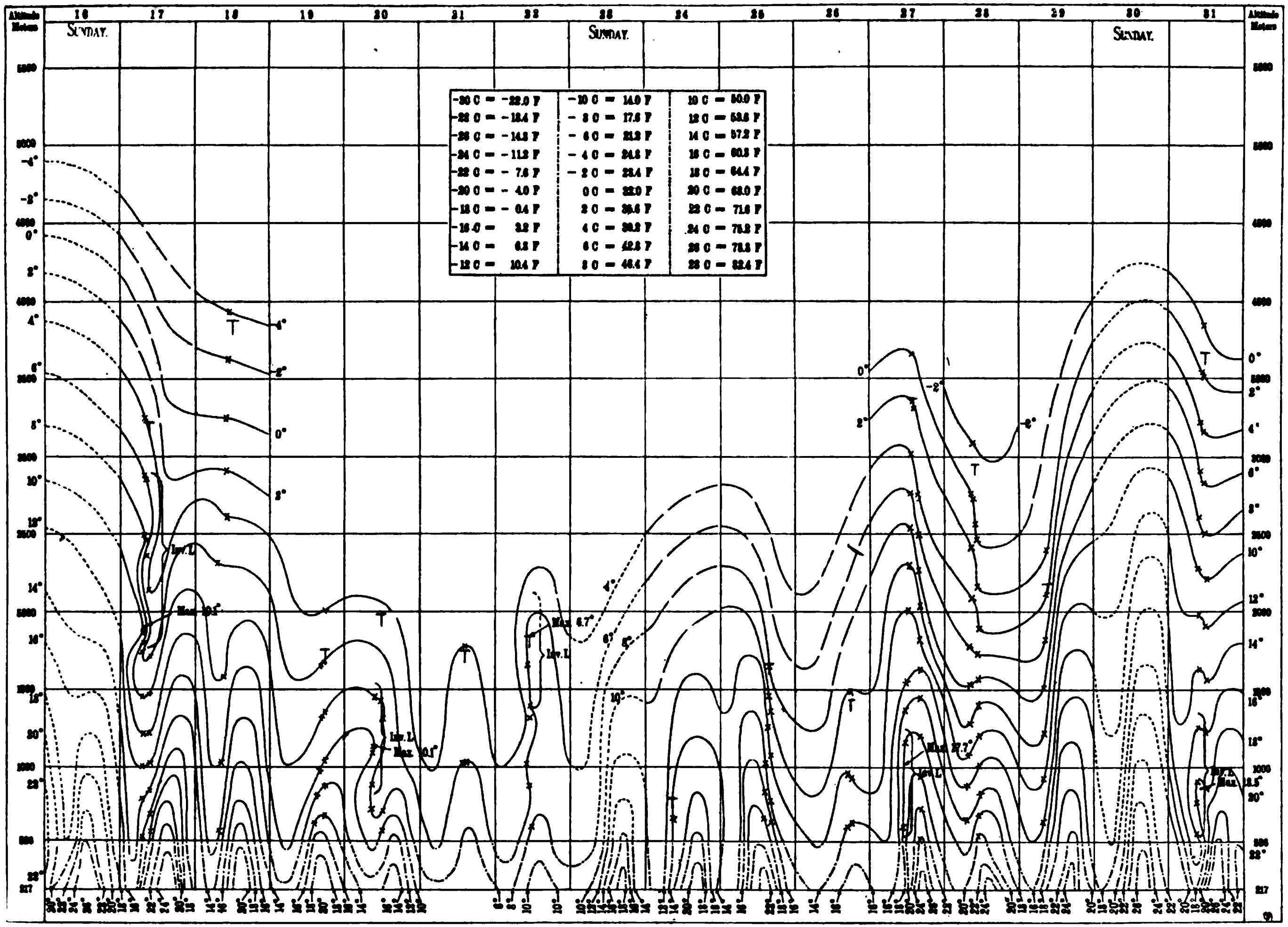
Upper air isotherms, April 1-15, 1909.



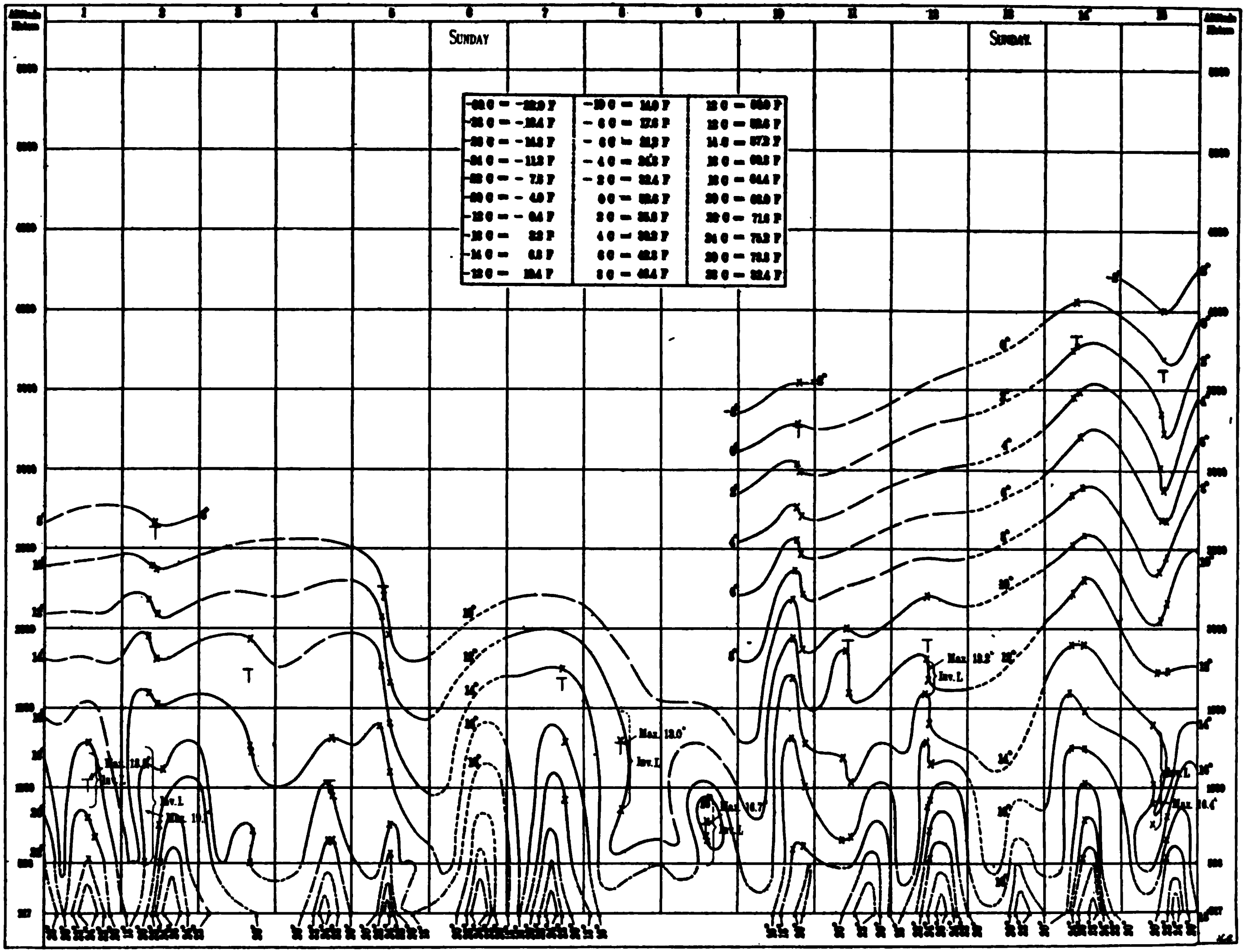
Upper air isotherms, April 16–30, 1909.



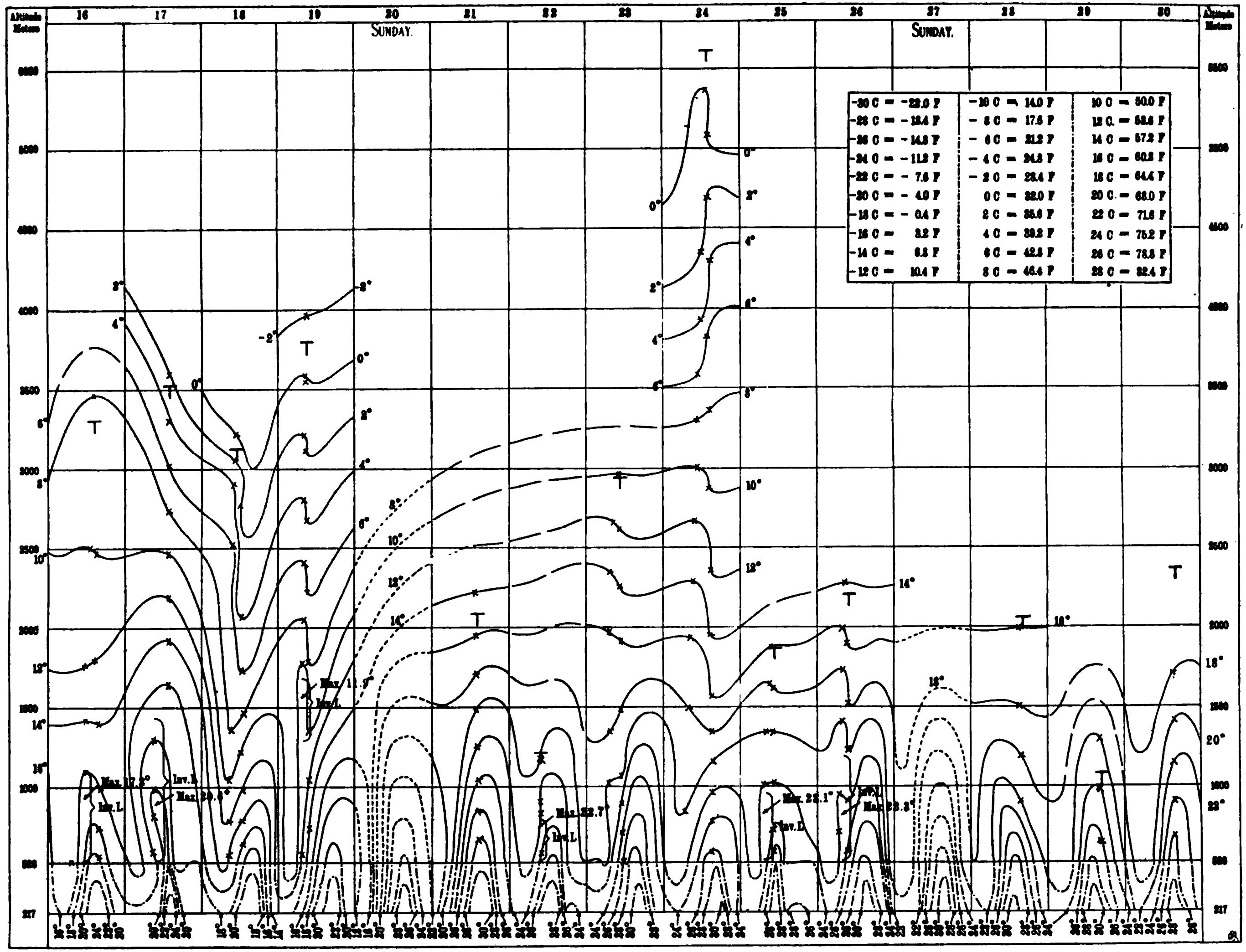
Upper air isotherms, May 1-15, 1909.



Upper air isotherms, May 16–31, 1909.



Upper air isotherms, June 1–15, 1909.



Upper air isotherms, June 16–30, 1909.

W. B. No. 428 Date of issue, May 14, 1910

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Vol. II

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Part 5

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MOUNT WEATHER OBSERVATORY

PREPARED UNDER THE DIRECTION OF
WILLIS L. MOORE, D. Sc., LL. D.
CHIEF U. S. WEATHER BUREAU

WASHINGTON
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1910

CONTENTS.

Closed March 4, 1910.
CLEVELAND ABBE,
Professor and Editor.

(I) ATMOSPHERIC PHENOMENA AND HALLEY'S COMET.

By W. J. HUMPHREYS. (Dated January 10, 1910).

Comets are, probably, the most mysterious of all celestial objects. Whence they come; whither they go, when they leave forever; where they gather fresh material, if they do, and how; their mechanical structure; the forces that commonly bind them together; the other forces that sometimes tear them apart; the origin of the curious knots, twists, and streaks in their tails; and why it is that they are self luminous, are among the things concerning comets we should like to know, but which, at present, no physicist and no astronomer can tell us.

It is but natural therefore that the return, and near approach of Halley's comet should arouse unusual interest and activity in the study of these strange objects, for it is bringing us a rare chance (especially if, as seems likely to be the case on or about the 18th of May, 1910, the earth should pass through its tail) of learning much that we would like to know in regard to comets and their accompanying phenomena. But to make such a study most efficient it is necessary to consider what phenomena may possibly be expected, and how they can be observed.

There are two distinct kinds, namely:

I. Celestial; astrophysical in the main.

II. Terrestrial; chiefly meteorological.

Among the former are:

(a) *Gross appearances.*—This includes all distinctive markings, such as bright patches; streaks, both straight and twisted; number, direction, and shape of tails; time and manner of beginning and ending of tails; and any other such phenomenon as may present itself to the observer. A photographic record, as nearly as practicable continuous, should be taken of these phenomena for future study, but it would be well to supplement the photographs by numerous eye observations.

Any one expecting to do work of this nature, and there are many observatories adequately equipped for it, would do well to consult Prof. E. E. Barnard, of the Yerkes Observatory, either directly or through his papers on comets.

(b) *Spectrum.*—Visual and photographic analysis of the light should be applied to the comet in detail—to the jets and envelopes in and about the head, to the streaks in the tail, and to all portions bright enough to yield results.

Such a program, while of decided value, can not profitably be under-

taken except by those observatories especially well equipped for this sort of work.

(c) *Polarization.*—It is known that the light of comets is polarized to some extent, from which it is inferred that a part of their luminosity is due to reflected sunlight, but this phenomenon needs further examination, and, in particular, separation from sky polarization. It would be well to compare the polarization of that part of the comet where a right angle exists between the directions from it to the sun and the earth respectively, with the polarization of other portions. If the particles of the comet are small in size, compared to the cube of an average wave-length of light, then, as Rayleigh has shown, there will be marked polarization of the scattered light that is a maximum (complete) in a direction at right angles to the incident radiation. It is true that we have in the turning of the tail always away from the sun strong evidence (since this is due, we believe, to light-pressure) of the minute size of the luminous particles; but, nevertheless, such evidence as the phenomena of polarization can give on this point is worth having.

It would also be desirable to determine the relative amount of reflected to intrinsic light, though the method of accurately doing this is not obvious.

Polarization work can be done with any *refracting* telescope of large light gathering power. A reflecting telescope could not be used for this purpose because of the polarization effects that it itself would introduce.

(d) *Light-fluctuation.*—It is well known that the light of comets often varies irregularly and without obvious cause. These variations should be studied in connection with the formation of jets and envelopes, and especially observed to see where the changes in brilliancy have their origin and how rapidly they spread to other parts.

The position and size of sun spots, and other solar phenomena, should also be observed and studied in connection with the light changes. Evidently the luminescence of comets is, in some way, largely dependent upon the sun, and it has been claimed that it is greatest during periods of sun spot maxima. If so, then it may change with the size and orientation of the spots. At any rate, this is a phenomenon that can easily and, perhaps, profitably be studied with the aid of even a very modest equipment.

All the above phenomena can be observed at any time the comet is brightly visible, but there are a number of other phenomena which possibly may appear or be modified during the passage of the earth through its tail, if, fortunately, such an occurrence should happen, and which, therefore, ought to be carefully watched at that time. These

form the second or terrestrial group, above mentioned, some of which are:

1. *Electrical potential.*—In reality it is the difference between the electrical potentials of two points a given vertical distance apart in the atmosphere that is here referred to. This would be modified by the bringing of an electrical charge from some extraneous source to the atmosphere, and, conceivably, might therefore help to give some idea of the electrical condition of that part of a comet's tail through which we happened to pass. But, as the electrical state of the atmosphere changes so greatly from place to place and from day to day, it does not seem that observations of this nature can afford much definite information.

2. *Atmospheric conductivity.*—This comes, essentially, to the same thing as the ionization of the atmosphere, and would be modified by the entrance into the air of charged particles or other ionizing agents.

Like the electric potential of the air this, too, is subject, ordinarily, to such changes that, seemingly, no trustworthy inference in regard to the electrical condition of a comet's tail, should we pass through one, could be drawn from such observations.

However, if any one, not entirely familiar with them, wishes to take up either or both of these lines of work he will find Gockel, Die Luftelektrizität, a good guide.

3. *Damping of electrical waves.*—It is well known that the distance a wireless message can be received changes irregularly, owing, presumably, to the intensity and distribution of the ionization of the atmosphere. The ease or difficulty of transmitting wireless messages, especially over the ocean, say from San Francisco to Honolulu, might therefore give some hint about the electrical state and the ionizing action of the material of a comet's tail through which the earth at that time might chance to be passing. Probably the hint would not be a very distinct one, but observations of this phenomenon seem to the author much more promising of results than do those of either the potential or the conductivity of the atmosphere.

4. *Earth currents.*—A marked change in the electrical condition of the atmosphere is likely to lead to earth currents of greater or less magnitude. It might, therefore, be well to request telegraph and telephone companies to report any such disturbances as may occur during our passage through the comet, should this happen. However, such currents should be considered only in connection with other phenomena, since alone they can have but little meaning.

5. *Diurnal variation of the earth's magnetism.*—It has been known for

a long time that there is regularly both a diurnal and a semidiurnal variation in all the elements of terrestrial magnetism; and it has been shown by Schuster[1] that the origin of these daily disturbances is outside the surface of the earth. The origin of this variation is, probably, the Foucault currents caused by the sweep of the ionized, and therefore conducting, air across the lines of magnetic force. The more ionized, or the better conducting the air, other things being equal, the greater these currents and, if this theory is correct, the greater the resulting diurnal variation in the records obtained at magnetic observatories.

If, then, the particles of a comet's tail are highly electrified, or should in any way produce, on our coming into them, an ionizing action on the atmosphere, there must result corresponding changes in the diurnal variations. The action of the cometary particles, presumably, would be on the outer layers of the atmosphere where any change in the conductivity is most effective. Also since, in general, the winds increase with latitude and the lines of magnetic force become more concentrated and more nearly vertical, therefore any change in the diurnal variation, especially of the declination, that may be due to the action of a comet's tail, probably would be most marked in the higher latitudes.

It seems, therefore, that it would be especially well to study and compare the diurnal variations obtained at the many excellent magnetic observatories just before, during, and just after the coming passage of the earth through the tail of Halley's comet—assuming, of course, this event to take place.

6. *Auroral displays.*—Auroras serve as rather delicate indicators of the electrical state of the outer atmosphere, and therefore should be carefully watched for and minutely noted during a continuous period of several days equally overlapping the supposed epoch of our intersection with the material of the comet.

7. *Line and band absorption.*—The atmospheric absorption lines and bands furnish about the best means we have for detecting changes in the composition of the atmosphere, especially of the outer portions. Therefore, it may be desirable to compare the atmospheric lines and bands during the passage of the earth across the comet's tail with the lines and bands obtained at other times.

If the electrification of the outer air is materially changed during this passage there may result a corresponding temporary change in the amount of ozone in that region, that perhaps could best be detected through the great ozone absorption band[2] at wave-lengths 9μ to 10μ.

[1] Phil. Trans., A., vol. 180, p. 467, 1889; vol. 208, p. 163–204, 1908.

[2] Ångström. Arkiv för Matematik, Astronomi och Fysik, 1, 395. 1904.

8. *Atmospheric transmission.*—In reducing the data obtained with integrating pyrheliometers it is customary to use, with certain corrections, the simple Bouguer equation,

$$I = I_0 a^m$$

in which I is the observed solar intensity through the air mass m, I_0 the intensity outside the atmosphere, and a the coefficient of transmission. This latter varies from day to day, but, assuming it to remain constant for a few hours, can be determined by observations taken with different values of m or, as Kimball[3] has shown, by a single observation of the intensity, together with a simultaneous measurement of sky polarization.

Since a is such a variable quantity its determination while, perhaps, of some value in this connection, can not be regarded as very promising of definite information concerning the material of a comet through which we might be passing.

9. *Meteoric trails.*—Since the particles composing the tail of a comet presumably are excessively minute, any meteoric trails they may produce on coming in contact with the atmosphere must be small. However, it would be well, at the proper time, to watch for them with a telescope pointed nearly vertically and focused for a distance of from 100 to 150 miles. Presumably only faint scintillations, probably entirely too faint to be seen, need be expected, but only by such observations can we know definitely just what does or does not take place.

10. *Bishop's ring.*—After the explosion of Krakatao, and also after that of Mont Pelé, a faint reddish-brown ring of the coronal type was seen about the sun. Its inner radius was about 12°, and its outer approximately 22°. It was due, almost certainly, in both cases, to finely divided matter thrown up to great altitudes and from there spread widely over the earth. The mean radius of these particles, assuming them spherical in shape, has been calculated to be about equal to the longest visible wave-length. They were therefore excessively minute, and it is possible that after passing through the tail of a comet something of this kind may be seen; at any rate careful observation should be made for it, after such an event, by those of exceptionally sensitive eyes. Such observations are best made with the sun hidden behind an opaque object.

11. *Color of the sun.*—The color of the sun, as is well known, depends upon the size and number of solid or liquid particles through which it is seen, and therefore may, possibly, be temporarily modified on our passing through a comet's tail.

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[3] Mount Weather Bulletin, 2, pp. 55–65, 1909.

12. *Atmospheric polarization.*—This phenomenon depends mainly upon the scattering of sunlight by any minute particles in the atmosphere. The percentage of the polarized to the total skylight at any part of the sky, say where the polarization is a maximum, or 90° from the sun on the vertical circle passing through it, is a function of the dust content of the air. This percentage, therefore, should be carefully noted during our supposed coming passage through the tail of Halley's comet, as should also the positions of the so-called neutral points of Arago, Babinet, and Brewster—the first especially, as it is the easiest observed and most accurately determined.

It might also be advisable to observe the polarization percentage of different colors, by the aid of suitable screens, since this depends upon the size of the particles that scatter the light.

13. *Twilight phenomena.*—Twilight colors, and the gamut of changes through which they run, clearly are dependent upon the dust content of the atmosphere, as was strikingly evident after the eruption of Krakatao, and therefore might, possibly, afford some information in regard to the tail of any comet through which the earth may pass.

14. *Luminous clouds.*—After the eruption of Krakatao there was seen for many years, but only in latitudes of 45° or more, faintly luminous clouds of, seemingly, great altitudes.

It is not at all certain that these so-called clouds were due in the least to the volcanic eruption; but still they should be closely looked for at the time of and after our passage through a comet's tail, since they might be modified by the material thus picked up.

15. *Number of dust particles in the air.*—The number of dust particles, especially in the outer portions of the atmosphere, may be greatly increased by the passage of the earth through the tail of a comet. Therefore, it would be well to count the particles of dust per cubic centimeter, say, of air on the tops of high mountains, and in samples obtained by sounding balloons, before and just after the time of our entrance into the tail of Halley's comet.

16. *Zodiacal light.*—While our knowledge of the nature and location of the material to which the zodiacal light is due is practically *nil*, nevertheless it seems quite possible since, as Fath[4] has shown, it presumably is reflected sun light, that its real or apparent brilliancy may be greater during our passage through even so rare a substance as the tail of a comet. Therefore, the details of this phenomenon, too, should be recorded, at the proper time, by those so situated as to observe it to good advantage.

[4] Lick Observatory Bulletin, No. 165.

17. *Gegenschein.*—Presumably the gegenschein is but that portion of the zodiacal light seen at about 180° angular distance from the sun. Hence it seems not improbable that it may be more distinctly visible during the passage of the earth through the luminous particles of a comet's tail, and therefore it should be studied, at the proper time, with the greatest care by those in the habit of observing it.

18. *The auroral line.*—Arrhenius[5] says, "Whichever way we turn the spectroscope on a very clear night, especially in the Tropics, we observe this peculiar green line. (The so-called auroral line.) It was formerly considered to be characteristic of the zodiacal light, but on closer examination it has been traced all over the sky, even where the zodiacal light could not be observed."

Evidently the source of this line is not definitely known, but, conceivably, it may be rendered more brilliant by the passage of the earth through the tail of a comet, and therefore it would be well for some favorably situated observer carefully to measure its brilliancy on several consecutive nights, so selected as symmetrically to overlap the calculated date of our supposed passage through the tail of Halley's comet.

The most promising, in this connection, of the above phenomena are, in the author's opinion, those designated as a, b, c, d, 5, 6, 9, 10, 13 16, and 17, to the successful observance of which, except number 5, clear skies are essential.

The above is not claimed as a complete list of the phenomena that may be associated with a comet, but it is hoped that they, together with others that they may suggest, will soon give us a better understanding of comets in general and of Halley's in particular.

[5] Worlds in the Making, p. 116.

(II) THE ISOTHERMAL LAYER AND THE TEMPERATURE OF THE EARTH.

By W. J. HUMPHREYS. (Dated February 18, 1910.)

Now that we are aware of the existence of an isothermal layer extending, so far as we know, over the entire earth, it is pertinent to ask what effect this layer can have on the temperatures of the earth and the lower atmosphere.

There are good reasons, though perhaps they need not be repeated here, for believing the atmosphere above the level of the upper inversion to be comparatively rich in ozone, a substance selectively absorptive both of solar and of terrestrial radiations.

The problem, therefore, may be stated as follows:

Will a spherical shell, selectively absorptive both of radiations from without and of those from an object within, but without power of reflection of either, raise or lower the temperature of a nonreflecting opaque enclosed object?

Since the coefficient of absorption is independent of intensity of radiation, an approximate solution can be reached by considering stable conditions, with the shell radiating equally in both directions—out and in.

Fixing our attention now on this isothermal layer (the shell) and its effect on the temperature of the earth and air below it:

Let I_0 be the average intensity of the normal component of the solar radiation incident on the shell, then

$$I_0 = I\frac{\pi R^2}{4\pi R^2} = \tfrac{1}{4}I,$$

where R is the effective radius of the earth as an absorber of solar radiation, and I the solar intensity at the limit of the atmosphere.

Let aI_0 be the portion of this average normal component of the radiation absorbed by the shell.

Approximately, and for convenience we will assume exactly, half this energy is radiated to space and half to the earth. If we count the lower atmosphere as a part of the earth, or if for simplicity we neglect its presence, we now have for the radiation intensity reaching the earth, assuming zero albedo, or no reflection from clouds and other things below,

$$I_0(1-a)+\tfrac{1}{2}aI_0.$$

The first term has to do with that portion of the solar radiation that is unabsorbed by the shell; the second with that half of the absorbed solar energy radiated to the earth by this shell. The two together give an intensity amounting to $I_0\left(1-\frac{a}{2}\right)$.

When equilibrium with this intensity is reached, the earth will send back an equally intense radiation of its own, but one in which the energy is very differently distributed as to wave-length. Therefore, when this equilibrium is established, $I_0\left(1-\frac{a}{2}\right)$ is also the intensity of the earth radiation.

Let $bI_0\left(1-\frac{a}{2}\right)$ = the portion of this outgoing energy absorbed by the shell. One-half of this, or $\frac{b}{2}I_0\left(1-\frac{a}{2}\right)$, will be radiated back to the earth, there to be absorbed, and once more sent out. The next amount returned by the shell is $\left(\frac{b}{2}\right)^2 I_0\left(1-\frac{a}{2}\right)$, and so on indefinitely.

The total intensity of normal radiation, therefore, reaching the earth is

$$I_0\left(1-\frac{a}{2}\right)\left\{1+\frac{b}{2}+\left(\frac{b}{2}\right)^2+\ldots+\left(\frac{b}{2}\right)^\infty\right\}$$

With a little reduction this takes the form

$$I_0\left[1+\tfrac{1}{2}\left\{1+\frac{b}{2}+\left(\frac{b}{2}\right)^2+\ldots\ldots+\left(\frac{b}{2}\right)^\infty\right\}\left\{b-a\right\}\right.$$

Now, b is either unity, the maximum value possible, or less—probably much less—and positive. Therefore, the terms enclosed by the first pair of braces form a rapidly converging series, whose maximum value, when $b=1$, is 2, and whose minimum value, when $b=0$, is 1, but whose actual value, in the case under consideration, probably is but little greater than unity. For brevity we will call it $2k$.

The average intensity of the normal component of the radiation reaching the earth is then

$$I_0\left\{1+k(b-a)\right\}$$

But the average intensity of the normal component of the radiation that would reach the earth, if there were no absorbing shell, is I_0, and clearly the former is greater than, equal to, or less than the latter

according as b is greater than, equal to, or less than a. Or in symbols

$$I_0 \left\{ 1+k(b-a) \right\} \gtreqless I_0 \qquad \text{according as}$$

$$b \gtreqless a.$$

That is to say, the earth is warmer, unchanged, or colder, when surrounded by an absorbing shell, according as the shell's coefficient of absorption for earth radiation is greater than, equal to, or less than its coefficient of absorption for solar radiation. Briefly, if the shell lets heat in better than it lets it out, the enclosed object will get warmer; but if it lets heat out better than it lets it in, the enclosed object will get colder.

We do not know the numerical value of either a or b, but from the distribution of the energy in the solar spectrum and the approximate energy distribution in the spectrum of earth radiation, together with the location and intensity of the absorption bands in ozone, we can pretty safely conclude that b is greater than a.

Assuming $a=0.05$, and $b=0.20$, values that may be roughly of the proper order, and writing I_e for the average intensity of the radiation received on the surface of the earth when I_0 is the average intensity of the solar radiation on the shell, we have

$$I_e = 1.083\, I_0.$$

Assume the earth to radiate according to the laws of the full radiator or black body, as it does approximately, and let its absolute temperature, without the shell, be 282° C. Then, since the radiation of the black body is directly proportional to the fourth power of its absolute temperature, we have

$$\left(\frac{T}{282}\right)^4 = \frac{I_e}{I_0} = 1.083,$$

in which T is the absolute temperature of the earth, when surrounded by the shell in question, with the assumed coefficients of absorption. This gives $T=287.66°$ absolute centigrade, which is about its average value.

It must not be forgotten that these are the equilibrium temperatures, under the assumed conditions of *cloudless* skies and an equal temperature for the surface of the earth. But these are not the conditions that actually do obtain, and therefore the above can be regarded as only an approximate general solution. The problem of determining the actual effect of the isothermal layer on the temperature of the earth is com-

plicated by the alternations between day and night, by the constant changes, during the day, in the sun's inclination, by reflection, especially from clouds, and, doubtless, by many other things that more or less modify the general result.

The adoption of average conditions (permissible by virtue of the fact that the coefficient of absorption is independent of intensity) eliminates, at least in great measure, the effects due to alternations of day and night and of the changing inclination of the sun. There remains, however, the important condition of reflection that was supposed, for the above solution, to be zero. It is possible to take this into account and still obtain a simple solution, as will be seen in what follows.

We will adopt $\frac{1}{3}$ as the average total albedo, or average reflecting power of the earth and cloudy atmosphere for solar radiations of all wave-lengths. Abbot and Fowle[1] determined it to be about 37 per cent.

The reflected portion of the solar energy, of course, has no effect on the temperature or on any other condition of the earth. That which is not reflected, or the effective portion, therefore, is all that need be considered.

Let I_0' be the average intensity of the normal component of the effective solar radiation over the entire earth. Then

$$I_0' = \tfrac{2}{3} I_0 = 0.17\, I, \text{ nearly.}$$

Let $a I_0'$ = the average amount of solar energy, both direct and reflected, absorbed by the outer atmosphere per second per unit area. Half this, approximately, is radiated to space and half to the earth, including the lower atmosphere in this term.

The earth now receives $(1-a)\, I_0'$ solar energy per unit time and area, and $\frac{a}{2} I_0'$ energy per same time and area from the absorbing outer layer which, presumably, is roughly coincident with the isothermal layer and rich in ozone. The two together amount to $I_0'\left(1-\frac{a}{2}\right)$.

After a time (assuming that we have started with a cold earth) the earth will send back an equally intense radiation of its own, but one in which the intensity of radiation is very differently distributed as to wave-length. Therefore when equilibrium with this radiation is established $I_0'\left(1-\frac{a}{2}\right)$ is the intensity of the outgoing earth radiation also.

Let $b I_0'\left(1-\frac{a}{2}\right)$ be the part of this long-wave earth radiation absorbed

[1] Annals of the Astrophysical Observatory, Smithsonian Institution, vol. 2, p. 163, 1908.

by the outer layer. One-half of this, or $\frac{b}{2}I_0'\left(1-\frac{a}{2}\right)$, will be radiated back to the earth, there absorbed and once more sent out. The next amount returned by the shell is $\left(\frac{b}{2}\right)^2 I_0'\left(1-\frac{a}{2}\right)$, and so on indefinitely. Hence the total intensity of the radiation reaching the earth is

$$I_0'\left\{1-\frac{a}{2}\right\}\left\{1+\frac{b}{2}+\left(\frac{b}{2}\right)^2+\ldots\ldots+\left(\frac{b}{2}\right)^\infty\right\}.$$

As before, b is either unity or less, probably much less, and positive, and therefore the terms within the second pair of braces form a rapidly converging series. Calling the sum S we have $I_0'\left(1-\frac{a}{2}\right)S$ as the intensity of the energy actually used to heat the earth.

Since the albedo of the earth is roughly $\frac{1}{3}$ we can say that the sum of the incident and reflected energy passing through the outer layer of the atmosphere is approximately $\frac{4}{3}$ of that originally incident, so that $\frac{1}{3}aI_0'$ represents the absorption per unit time and area of reflected radiation. If there were no absorption of solar radiation in the outer layer, then, of the additional $\frac{4}{3}aI_0'$ that would go on per second to each unit area of the earth, one-third, or $\frac{1}{3}aI_0'$, would be reflected.

Therefore, if the outer absorbing layer did not exist, the average intensity of the energy used in warming the earth would be $I_0'\left(1-\frac{a}{2}\right)$ while that which actually is used in this way is $I_0'\left(1-\frac{a}{2}\right)S$.

As before, let $b=0.20$, then $S=1.11$, or the radiant energy actually received by the earth is 11 per cent greater than it would be if there were no absorptive layer.

The average temperature of the earth is 14.4° C.,[3] or 287.4° C., absolute. Therefore, since the percentage change in temperature is about one-fourth the percentage change in radiation, it follows, if the assumed value of b is correct, that the surface of the earth averages from 7° C. to 8° C., or say 13° F. warmer than it would be without the presence of the absorptive shell.

The amount of this difference in temperature depends, as we have seen, upon the value of b, and this in turn upon the quantity of ozone and other absorptive material in the upper atmosphere. But ozone owes its origin, presumably, to ultraviolet radiations from the sun and to electrical discharges. The latter, if we can judge by auroral displays, are most pronounced at the time of sun-spot maxima, and we can see, there-

[3] Hann, Lehrbuch der Meteorologie, p. 115.

fore, at least two reasons for expecting the temperature of the earth to change with the size and number of sun spots: (1) Because of a change in the intensity of the incident solar radiation; (2) because of a change in the coefficients of absorption of the upper atmosphere.

The two coefficients, a and b, will increase or decrease together, the greatest percentage change being in the smaller of the two and the greatest absolute change belonging, probably, to the larger. It may therefore even happen that a slight decrease in the output of solar energy, provided that it is accompanied by an increase in the ozone content of the upper atmosphere, will be followed by an increase and not a decrease in the earth's atmosphere. But the extent to which this temperature actually does change over the entire earth from spot maxima to spot minima is not well known, and it might therefore be of value, in this connection, to follow closely the temperature and height of the upper inversion level and, if possible, its ozone content, through one or more cycles of solar changes.

(III) LATITUDE EFFECT ON THE TEMPERATURE AND HEIGHT OF THE UPPER INVERSION.

By W. J. Humphreys. (Dated February 18, 1910.)

Both the height of the upper inversion level and the temperature of the isothermal region depend, as is well known, upon season, weather conditions, and latitude; and of these probably the latitude effect has been the most puzzling.

The number of sounding balloon observations, obtained at places differing widely in latitude, is not sufficient to give reliable quantitative averages of latitude effects, because the results secured by a single flight, or even by the combination of several flights, are certain to depend in part upon mere weather conditions. However, in spite of marked irregularities in the heights of the inversion level and in the temperatures of the isothermal layer, as found from day to day at any given place, there appear, when the observations made at different stations are compared, pronounced latitude effects, the qualitative nature of which seems certain. Numerical values though, as just stated, are not yet assignable—in fact, on account of the irregularities of some of the causes, there may be no constant value for these effects.

Table 1 gives a summary of our present knowledge of the relations between the four quantities: (a) height of the inversion level, (b) temperature at the inversion level, or of the isothermal region, (c) surface temperature, and (d) latitude.

Table 1.—*Relations of the upper inversion to latitude.*

Height of upper inversion level: Km	16–17	15	13	12.5	10.6	9.6	9.5
Upper inversion temperature	−71° C.	Not given	Not given	−57° C.	−57° C.	−55° C.	−60° C.
Surface temperature	25° C.	Not given	Not given	17° C.	10° C.	5° C.	−9° C.
Difference of temperature	96° C.	Not given	Not given	74° C.	67° C.	60° C.	51° C.
Number of cases	3	Not given	Not given	22	290	28	Not given
Latitude	0°	23° N.	38° N.	38° N.	49° N.	60° N.	68° N.

For the sake of clearness in explaining this table the several columns will be taken up individually.

The data of column 1, concerning conditions at the equator, are given by Assmann[1] in a preliminary report of the German aerological expedition to tropical east Africa. The height at which the inversion level was found is not stated exactly, in this preliminary report, for any of the

[1] Quarterly Journal Royal Meteorological Society, **35**, 52, 1909.

flights, but in at least one case it certainly was not more than 17 kilometers. On the other hand it is known from the reports of the cruise of the *Otaria*[2] that the isothermal region was not reached near the equator at an elevation of 15 kilometers. Therefore, combining these two reports, we conclude that the level of the inversion layer at the equator is in the neighborhood of 16 to 17 kilometers above sea; or at any rate more than 15 kilometers, and consequently at a greater average height than it is known to be at any other place.[3]

The fragmentary information contained in columns 2 and 3 was obtained during the cruise, above referred to, of the *Otaria*.

The values given in column 4 were gathered from the reports[4] of sounding balloon work done at St. Louis under the direction of Rotch.

Column 5 gives the averages of values obtained at several European stations[5] at or about latitude 49°.

The data in column 6 are from results obtained at Pavlovsk,[6] near St. Petersburg.

Column 7 gives values found at Kiruna in north Sweden, and reported by Teisserenc de Bort.[6]

From Table 1, though of fragmentary and provokingly limited data, it appears possible to draw a few conclusions with tolerable certainty. These are:

1. That the altitude of the inversion level decreases with increase of latitude.

2. That the temperature at the inversion level is lowest in equatorial regions.

3. That the surface temperature decreases with increase of latitude. (Mentioned only for the sake of completeness).

4. That the difference between the temperatures of the surface and the inversion level decreases with increase of latitude.

Conclusions 1, 2, and 4 are the ones with which this paper is concerned.

It has been shown by Abbott and Fowle[7] that, because of the high coefficient of absorption that water vapor has for long wave-lengths, most of the planetary radiation of the earth comes from the water vapor in the atmosphere—generally at some distance above sea level. This, with the

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[2] Teisserenc de Bort, C. R. 148, 593, 1909.

[3] Since writing the above the complete report of this expedition has appeared, but it gives no occasion to change what has been said except perhaps to state that the inversion level is more nearly 17 kilometers than 16.

[4] Annals Harvard College Observatory, 68, part I.

[5] Gold and Harwood, Nature, 82, 49, 1909.

[6] C. R. 145, 149, 1907.

[7] Annals of the Astrophysical Observatory of the Smithsonian Institution, vol. II.

additional fact that the horizontal extent of area covered by the lower moist air is essentially the same as that of the isothermal region, enables us to write the following equations:

$$R = cT_1^n$$

$$aR = kT_2^m$$

and $$T_2 = \left(\frac{ac}{k} T_1^n\right)^{\frac{1}{m}} = bT_1^{\frac{n}{m}}$$

in which T_1 is the effective temperature of the radiating water vapor, i. e., the temperature of an equivalently radiating black surface; R, the energy radiated per unit of time and horizontal surface from the water vapor; T_2, the corresponding temperature of the isothermal region; c and n, water vapor constants of radiation; k and m, the corresponding radiating constants of the atmosphere of the isothermal region; and a, the fraction of R absorbed and, of course, reradiated by the upper air.

If n and m are essentially of equal value then we can write $T_2 = bT_1$, and from the observed values it appears, as shown in a previous[6] paper, that $b = 0.84$, approximately.

Now, as the equator is approached, the yearly average of R increases, since it must be equal to the average amount of solar energy absorbed per equal time and area. Hence T_1 increases with approach to the equator. At the same time that T_1 increases the amount of moisture in the atmosphere and its general level also increase, so that probably the level as well as the temperature of the effective radiating layer increases with decrease of latitude.

Assume the equation $T_2 = 0.84\ T_1$, which is approximately true for middle latitudes, to hold for the entire earth. Then the greater the value of T_1, or the less the latitude of the place, the greater the difference between T_1 and T_2. Also, if h is the difference in elevation corresponding to a change in temperature of 1°, above the effective level, or height H where the temperature is T_1, then the inversion height, H_i, is given by the equation

$$H_i = H + 0.16T_1\, h.$$

As just explained, it is probable that H increases with increase of water vapor, which ordinarily is greater the higher the temperature, and of course if h is constant, and it is approximately so, then the term to which it belongs must increase directly with increase of T_1. Hence the height, H_i, of the upper inversion must increase as the equator is approached.

But this is not the whole story. According to the above theory, in its simple form, an increase of T_1 means not only an increase of H_i, which

[6] Astrophysical Journal, vol. 29, p. 14, 1909; this Bulletin, vol. 2, part 1, 1909.

qualitatively corresponds with observation, but also an increase of T_2, which is exactly the reverse of observation. It is this fact that makes latitude effects so full of interest and so suggestive.

The foregoing théory is based on the assumption that the composition of the upper air, and therefore its coefficient of absorption for any given radiation, remains constant, and that only the supply of radiation from below varies. This assumption of constancy of composition is supported by the fact that samples of air taken from an elevation of 14 kilometers,[9] when examined spectroscopically fail to show any marked differences in composition. However, this examination appears to have been confined to the rare gases, helium, argon, neon, and others, and, therefore, can not be regarded as conclusive; moreover, the method followed probably would not be adapted to detecting the presence, in the region of the upper inversion, of such unstable compounds as ozone and nitrogen pentoxid—which substances, ozone especially, presumably are there in appreciable amounts.

The dry cold air of the isothermal region is acted on during the day by solar radiation, the ultraviolet portion of which must here act just as short wave-length radiation does under similar conditions in the laboratory, that is, convert more or less of the oxygen present into ozone. Besides this source of ozone in the upper air there is another and a prolific one, namely, electric discharges of the silent or Geissler tube type, and these appear to be more intense in the higher latitudes. As is well known auroral displays are seldom seen in equatorial regions, but are observed with increasing frequency, finally becoming of almost daily occurrence, as one approaches the zone of maximum frequency encircling a magnetic pole.

The auroral streamers—the paths, as we believe, of electric discharge—follow approximately the lines of magnetic force, and therefore are parallel, roughly, in most places, to the planes of the geographic meridians. Hence the density of the auroral discharge, assuming the current to be constant from equator to pole, increases as higher latitudes are reached, and besides an increasing proportion of it, by following the lines of force well down into the oxygen region, becomes effective as an ozonising agent.

Let S and E be the average ozonising actions per vertical column of unit cross sections of the insolation and the electric or auroral discharges respectively at the equator, assuming unit current effective. Then, at the latitude θ, the total action, Q, per similar column, may be written approximately as

$$Q = S \cos \theta + N_\theta E \sec \theta,$$

[9] Teisserenc de Bort. C. R. 147, 219, 1908.

where N_θ is the effective or ozonising current at latitude θ. Hence, if $N_\theta E$ is equal to or greater than S, as possibly it is, the higher the latitude the greater the value of Q, or the richer the upper air in ozone. Besides there probably are many electrical discharges in the upper air of high latitudes that do not extend to the Tropics; and further the general circulation of the upper air from equatorial regions to higher latitudes must tend to deplete the ozone supply in the air of the former regions and to augment it in that of the latter.

It is well known that ozone has a strong absorption band[10] extending from 8.5μ to 10.5μ, approximately; which is also a region of intense terrestrial radiation. Further, it has been shown by Ångström[11] that spectrobolograms of the sun, as taken by himself, give evidence of an abundance of ozone in the upper atmosphere.

We may conclude, therefore, that the elevation and the temperature of the upper inversion level will depend upon (a) the amount of radiation from the lower atmosphere, or its temperature if we prefer, and (b) upon the portion of this absorbed by the isothermal layer, or upon the composition of the air of this region. We may also conclude that this upper air is rich in ozone, due in all probability, to the action of (1) ultraviolet solar radiation and (2) electric discharges, especially of the auroral type; and, finally, that this quantity of ozone must be a function, probably an increasing one, of latitude.

A region of the outer atmosphere that is poor in ozone, as the equatorial portions may be, can not be a good absorber of terrestrial radiation, and must therefore have a proportionately low temperature—a temperature that is reached by the convective lower atmosphere only after it has risen to a correspondingly high level. This probably explains why the isothermal region is both higher and colder in equatorial regions than elsewhere. This latitude effect on the temperature of the isothermal region tends to equalize the temperatures of the earth. It helps to keep the Tropics from getting intolerably hot and the regions of high latitudes from becoming unbearably cold.

If ozone is present to an appreciable extent in the upper atmosphere, and both observation and experiment indicate that it is, it clearly must play an important part in determining the rate at which the earth can radiate to space, and therefore in fixing its temperature.[12] With maximum auroral displays, other things being equal, there will be a maximum blanketing from ozone and a corresponding slight increase in the general

[10] Ladenburg und Lehmann, Ann. d. Phys. 21, 305, 1906.

[11] Arkiv för Matematik, Astronomi och Fysik, 1, 395, 1904.

[12] See preceding article in this Bulletin.

average of the surface temperatures. However, these displays are greatest when sun spots are most numerous and largest, and as these are regions of relatively feeble radiation it may be that sun spot maxima are accompanied by minima in the solar output of radiant energy; so that when the earth receives a minimum of energy from the sun its ozone blanket, assuming it to be chiefly due to auroral discharges, may be at a maximum. That is to say, when the earth gets least heat it may be most conservative of it, and when it gets most, least retentive, so that on the whole the average surface temperature may change but little so far as these phenomena are concerned.

But there is another phenomenon, the spectral distribution of solar energy, to consider. It has been shown by Abbott and Fowle[13] that the relative amounts of violet solar radiation may change perceptibly even when there is no evidence of a change in the solar constant. Now auroras increase with increase of sun spots, or at those times when the solar corona is most extensive and presumably, therefore, most effective as an interceptor of short wave length radiation. Hence the radiation and the auroras together maintain an approximate equilibrium in the amount of ozone in the atmosphere; but, as it increases and decreases, so too, other things being equal, must the general temperature of the surface of the earth.

CONCLUSIONS.

The height of the upper inversion increases and the temperature of the isothermal region decreases with decrease of latitude.

This probably is due to difference in the composition and consequent capacity to absorb terrestrial radiations, of the outer atmosphere—a difference due, presumably, to varying quantities of ozone caused by the unequal distributions of insolation and electrical discharges.

The ozone blanket appears to be thinnest and the outer air most diathermanous in equatorial regions.

If the ozone is due largely to auroral discharges, and if these vary, as they almost certainly do, with the size and number of sun spots, then sun spot maxima and sun spot minima should coincide with maxima and minima respectively of conservation of terrestrial energy, unless, as seems almost certain, an increase in sun spots is accompanied by a decrease in the violet radiation, in which case any effect would be the resultant of opposing causes.

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[13] Astrophys. Jr. 29, 281, 1909.

(IV) THE ATMOSPHERE.[1]

By R. S. Woodward.

There is a profound significance as well as an inspiring sentiment to be found in the words "Speak to the Earth and it shall teach thee", inscribed over the entrance to Schermerhorn Hall of this University, for the earth is at once the grandest of laboratories and the grandest of museums available to man. It would appear to be a singular circumstance, therefore, that the sciences of the earth are all in a relatively backward state as compared with the sciences of the heavens, and especially that the science of meteorology should be so much less popular and so much less understood than the closely related science of astronomy. Thus, to illustrate this difference of popular esteem and popular knowledge it may be observed that most people have studied enough of astronomy to learn the salient phenomena of the solar system, while very few people possess any but the vaguest notions of the phenomena of the weather. The procession of the seasons, the phases of the moon, and the satellites of Jupiter and Mars are tolerably well known, but with meteorology, on the other hand, popular knowledge is very limited. To most people "the wind bloweth where it listeth", while the polite literature and conversation of our times still counsel intellectual contentment with poetic illusions concerning the blissfullness of ignorance and the folly of wisdom with respect to all matters meteorological.

A closer inspection, however, of such anomalies shows that the order of development of the sciences is not a matter of chance, but that it is determined chiefly by the evolution of mind and by the intrinsic difficulties of the sciences themselves. As regards the two sciences in question, it is evident enough in the light of actual events that, although they emerged nearly contemporaneously from the fertile imaginations of our distinguished ancestors, astronomy was destined, for a long time at least, to outstrip meteorology both in progress and in popular favor. In the attainment of this noteworthy result three causes have been especially effective: first, the religious impulse of mankind for an attentive study of celestial phenomena; secondly, the relatively slow and majestic motions of the heavenly bodies due to their great distances asunder; and thirdly, the simplicity of the salient facts of astronomical science as compared with the salient facts of meteorology.

[1]A lecture delivered January 12, 1909, at Columbia University, New York, N.Y., as the first of a series of popular lectures on meteorology given by different authors during the first half of the year 1909.

It has thus happened that astronomy has led the way to progress not only for meteorology, but for all the physical sciences, including the biological sciences even under this designation. It is thus that astronomy under specially favoring conditions has won for itself the high place assigned to it by Laplace as "le plus beau monument de l'esprit humain".

But since Laplace recounted the achievements and sounded the praises of astronomy a century ago, a great development has taken place in many other branches of physical science. While his successors have not cultivated the science of the heavens less, they have cultivated the terrestrial sciences vastly more, and the latter are now in a position to repay whatever of debt they may owe to the former.

Among the geophysical sciences which have come rapidly forward in recent decades is the science of meteorology. During this time it has passed from the preliminary stage of amateurism and dilletantism, whereon it was possible to acquire a scientific reputation by merely reading a thermometer three times a day, to the plane of a highly theoretical and a highly practical and economic science. Hence, it must be esteemed an honor, as well as a privilege, to address to you the opening lecture of the course which Columbia University offers to the public on this important science.

For convenience of description and investigation, the earth, or general domain of geophysics, may be divided into four regions, namely, the centrosphere, or nucleus; the lithosphere, or crust; the hydrosphere, or oceans; and the atmosphere. The centrosphere is the part of the earth about which we know the least, although it is by no means a terra incognita. The lithosphere is the theater of the principal activities, mechanical and biological, of our planet; it is the special province of geologists and biologists. The hydrosphere serves to fix a surface of reference to which the refined measurements of geodesists are referred. The atmosphere is an ocean of gas in which we live. It is the province of meteorology. All of these provinces are related, however, and he who works successfully in one must make occasional, if not frequent, excursions into the others.

The properties of the atmosphere as they present themselves to the physicist of the present day may be conveniently subdivided under—

1. Properties of the atmosphere considered as gas.

2. Properties of the atmosphere considered as gaseous envelope under the action of the attraction and the rotation of the earth. These may be called its statical properties.

3. Properties of the atmosphere considered as a gaseous envelope under the combined action of the attraction, the rotation, and the hydrosphere

of the earth, and of the action of external bodies, especially the sun. These may be called its kinetic properties, since the latter include the statical properties.

It will be essential in the limited time available for this lecture to restrict attention chiefly to the salient features of the first two heads just enumerated. In other words, I may attempt only to indicate to you the nature of gases in general and the statical effects of the gaseous envelope of our planet. The considerations I shall present to you must therefore be regarded as first approximations to the more general and the far more difficult problems of meteorology.

First, then, let us enquire what are the characteristic properties of a gas. To do this we must fix our ideas by means of some elementary definitions implied in what follows. Solids are aggregations of matter which resist deformation, or tend to preserve their shapes. Fluids are aggregations of matter which offer little or no resistance to change of shape. Fluids again may be conveniently divided into liquids and gases, the former being noteworthy for their incompressibility and the latter noteworthy for their compressibility. Gases are, then, aggregations of matter remarkable for their mobility and for their compressibility. But they offer resistance to compression and tend to expand elastically when confined in an enclosure. This property of the atmosphere was first clearly defined by Robert Boyle in his work entitled New Experiments touching on the Spring of the Air, published in London in 1662. Independently, but a few years later, Mariotte defined the same property in his treatise De la Nature de l'Air. Briefly stated, the conclusion they reached, now known as the law of Boyle and Mariotte, is that the pressure of the gas is directly proportional to its density. Subsequent experiments, however, showed that this law holds good only for constant temperatures; so that the next step forward required a knowledge of the role of that important factor. This step was made near the beginning of the nineteenth century, and is credited jointly to Charles, Dalton, and Gay-Lussac. Their more general law asserts that the elastic pressure of a gas is proportional to the product of its density and its temperature. This is the basis of the so-called equation of condition of a gas.

Such, substantially, was the state of knowledge with respect to gases from about 1800 up to about 1850 when there began what has proved to be a very fruitful revival of the very ancient doctrine visualized by Democritus and poetized by Lucretius, namely, the doctrine of the atomicity of matter as opposed to the continuity of matter advocated by Anaxagoras. Passing rapidly from the remarkable though quite inadequate suggestions of these brilliant early contributors to the molec-

ular theory of matter, it may be said that the next distinct advance is due to an indication of Daniel Bernoulli. He clearly realized the concept that the pressure of a gas results from the impact of its particles on one another and hence on the sides of any enclosing vessel. Although equipped with the necessary knowledge of mechanics, he failed to establish this concept. The proof was thus reserved for the British physicist Joule, who nearly a century later, actually calculated the velocities which the particles of a gas must have to produce the observed pressures on the walls of an inclosure. Many other famous physicists, including Clausius, Helmholtz, Maxwell, and Kelvin, have since contributed to place this theory of the constitution of gases on an irrefragable basis; and it may be remarked that the establishment of this theory, founded, as we have seen, on experiments to determine "the spring of the air," has contributed wonderfully also toward the establishment of the doctrine of the universality of the atomicity of matter.

We are now able, therefore, by aid of the molecular theory of gases to define the characteristics of the atmosphere with much particularity. It was shown long ago by the chemist Priestley that the air is essentially a mixture of the two gases nitrogen and oxygen in the proportion, about, of 79 volumes of the former to 21 volumes of the latter; and it was proved by Dalton that each of these constituents acts mechanically independently of the other, so that the mixture may be here considered as a single or elementary gas. How, then, in the light of this theory or in the light of that sixth sense which Darwin attributed to mathematical physicists, are we to visualize this gas which is the medium of communication between you and me in this room? No one has yet seen particles of the air as we have all seen particles, or corpuscles, of blood. But we probably know much more about the molecules of gases than we do about blood corpuscles. By actual count it is known that there are four to six millions of the latter in a cubic millimeter; and with equal certainty calculation shows that there must be about a milliom million million molecules in a cubic millimeter of the air around us. In spite of this apparently densely crowded assemblage the individual molecules move about in the liveliest manner, their average speed being about 500 meters per second, although the average length of an unimpeded journey is barely visible by aid of microscopic devices. Each molecule must therefore collide with its neighbors astonishingly frequently, the encounters occurring, in fact, about five thousand million times per second.

These then are some of the salient characteristics of the gas under consideration. It is a relatively simple substance; but I trust you will

agree with me before this lecture is completed that it is a substance not without interest as a subject of study, especially when we reflect that it has been one of the principal stepping stones that have paved the way to the endless vistas now open to us for discoveries and advances in the domain of the molecular theory of matter. Under the influence of great heat gases become incandescent and exhibit the wonderful phenomena revealed in the sun, for example, by the spectroscope. Under the influence of sufficiently low temperatures gases become liquids. Similarly it is inferred that all known material elements and combinations of elements may be distinguished as solids, liquids, or gases according to their temperatures. But in all the endless diversity of forms of matter thus presented to us it appears that the integrity of the molecules is preserved. These appear to be the foundation stones, now and then rejected by eminent builders from Anaxagoras to the present day, on which physical science must rest until the secret of the molecule is penetrated and the atomicity of Democritus is realized.

Passing now to what I imagine most of you will consider a more practical field of inquiry, let me try to indicate to you the state of our knowledge concerning the quantity and mass distribution of the atmosphere. About ten years ago Lord Kelvin raised the rather ominous question of the possibility of an exhaustion of our terrestrial supply of oxygen; and in these days of attention to the conservation of national resources we may not improperly bear in mind our share of the atmosphere. Whether this quantity be much or little, exhaustible or inexhaustible, it should obviously be of interest to geophysics, if not to the more "dismal science" of political economy.

Before entering into some details of this inquiry it may be said that we are unable at present to state with precision what the total quantity, or mass, of the atmosphere is. We are only able to say that its amount lies between a sharply-defined lower, and an ill-defined upper, limit. With these facts before you—facts drawn from mathematical considerations which I may only allude to here—I proceed to explain historically how the statistical properties of the atmosphere may be investigated. To do this I shall ask you to consider, first, the ideal case of an earth without rotation; and, secondly, the more real case of an earth with rotation, the effects of external bodies being ignored in both cases. It may be observed, however, that external bodies, like the sun and moon, play an obviously unimportant role in respect to the general mass distribution of the atmosphere.

In the first case, it is plain that the earth would be surrounded by an ocean of uniform depth. But what depth this ocean would have is a

question not easy to answer. Let us approach it by the usual method of science, namely, by an appeal to observation and experiment combined with hypothesis. Observation and experiment show that the average pressure of the atmosphere at the surface of the earth is a sensibly constant amount; and the law of gravitation implies that this pressure is due to the attraction of the earth on the atmospheric mass. It is seen then that if we imagine a cone, whose vertex is at the center of the earth, to pass through the atmosphere, the pressure at the surface of the earth of the mass of air included in the cone must be just equal to the weight of that air. Hence if we can learn the mass distribution of the air in the cone and allow for the variation in attraction of the earth with distance from its center, we ought to be able to find the height of the upper surface, if there is any, of the air. The differential and integral calculus shows us how to do this. If we try the simplest hypothesis as to mass distribution, or assume perfect uniformity therein, it is found that the ocean of air would be 26,200 feet, or about 5 miles deep. This is called, in the literature of our subject, "the height of the homogeneous atmosphere," a very useful but purely fictitious quantity.

If we try the law of Boyle and Mariotte, to which reference was made earlier in this lecture, it is found to be incompatible with any limit to the height or to the mass of the atmosphere. This striking fact has surprised some eminent minds, for the rapid decrease in density with height required by this law would seem to imply both a limited depth and a limited mass of the atmosphere. The inapplicability of the law of Boyle and Mariotte is due to its neglect of the temperature factor. Hence it is sometimes called the isothermal law. How may this temperature factor be taken into account?

The answer to this question requires reference to two of the greatest names in the history of physical science, Newton and Laplace. Newton had shown that if the isothermal law holds, the velocity of sound ought to be expressed by the formula

$$v^2 = g\frac{p}{w}$$

wherein v is the velocity of sound, p is the pressure, and w the weight per unit volume of the atmosphere; and g is the acceleration due to the attraction and rotation of the earth. But the velocity calculated by this formula did not agree with experiments. The computed velocity was about 19 per cent too small. The cause of this large discrepancy, long a subject of diligent inquiry, was finally discovered by Laplace. He observed that in the transmission of sound waves there take place alternately condensations and rarefactions in the direction of propaga-

tion, and these give rise to an alternate heating and cooling of the air. Hence, also, during each condensation there is an increase and during each rarefaction a decrease of internal pressure of the air. Since the condensations and rarefactions in question follow one another with great rapidity, the air involved undergoes changes in pressure and density, without loss or gain to itself of heat. Following up this idea with his characteristic penetration, Laplace showed that the formula of Newton required modification by a constant factor whose value is 1.19 approximately.

The law which was thus found to apply in the transmission of sound by the air, and which has since been proved to be a close approximation throughout a considerable range of temperature, is called the adiabatic law. This means, in general, that whatever changes may take place in any part of a medium, that part suffers neither gain nor loss of heat. Since this law accords well with the properties of the atmosphere near the surface of the earth, we may fittingly inquire what sort of mass distribution it implies. A very interesting mathematical investigation shows that the adiabatic law would limit the depth of such an atmosphere to about 17 miles and its total mass to a little more than one-millionth part of the entire mass of the earth. Here we have something definite and tangible, although some of you may find difficulty in forming a clear mental picture of the amount of this atmospheric mass, for it is no less than six thousand six hundred million million million tons, viz, 6600×10^{18} tons.

But little observation is necessary to prove that the atmosphere is more than 17 miles high. The myriads of meteorites which fall into and are burnt up by the air daily show that it must be of considerable density at heights greater than 100 miles. The adiabatic law alone, like the isothermal one, is therefore inapplicable and we are forced to try other hypotheses. It should be observed, however, that the adiabatic law gives us one very important result, namely, a lower limit to the mass of the actual atmosphere of our planet. This is the sharply defined limit referred to above.

Passing now from the restricted case of a nonrotating earth to the actual case of a rotating earth, we at once encounter a higher order of difficulties. The case is still statical, however, for whatever might have been the primitive conditions, the atmosphere would sooner or later rotate with the earth and assume a mass distribution appropriate to the resultant effects of the attraction and the rotation of the centrosphere, the lithosphere, the hydrosphere, and the atmosphere combined. The first three of these spheres may be assumed to act essentially as one solid

centrobaric sphere, so that, happily, we need consider only this latter and the atmosphere. But, even so simplified, the problem presents difficulties which are as yet insurmountable. Let me endeavor to tell you what progress toward a solution of this problem has been made with the hope that the facts and the hypotheses involved may be made clear and distinct.

The measurable and known facts of the problem are the following five: the density, pressure, and temperature of the atmosphere, the acceleration of gravity at the earth's surface, and the common velocity of rotation. What we desire to find are the density, pressure, and temperature of the atmosphere in any other part of its mass, what is its limiting boundary, if it has any, and what is its total mass, if limited. Henceforth we must proceed by the aid of hypothesis.

If we assume that the air is a fluid in the sense that Anaxagoras and Laplace seem to have understood the word, then it follows, as Laplace has shown, that there must be a mechanical boundary to the atmosphere of any rotating planet. It is easy to see, in fact, that in such a case there must be an equatorial circle along which the attraction of the planet would be just balanced by the centrifugal force of an element of fluid rotating in this circle. This mechanical concept was entertained by d'Alembert, but its full application required the more extensive mathematico-physical equipment of Lagrange and Laplace. It must suffice to state here that Laplace proved that a "fluid" atmosphere for the earth would be confined within a lenticular shaped envelope whose polar and equatorial axes are, respectively, 4.4 and 6.6 times the radius of the earth. Any air that might escape across the boundary would no longer belong to the earth's system, and any air which might be drawn within this boundary would become a part of that system.

Laplace did not attempt to define a distribution of density for the atmosphere within his limiting envelope. He was content apparently with the assignment of that envelope. Any further advance, indeed, has been beset with difficulties from his day down to the present time. It has been essential to resort to hypotheses whose validity can not be, as yet, fully verified. Astronomical and meteorological observations show in a general way that the pressure, density, and temperature of the air decrease with increase of altitude above the surface of the earth. These facts guide in the selection of hypotheses, but, unfortunately, we are only lately learning how to make deep-sea soundings upward in the atmosphere.

Assuming the applicability of the earlier notions of the fluidity of the air, I have tried a series of hypothetical laws connecting pressure,

density, and temperature with a view of determining the distribution of density within the Laplacian envelope and hence an upper limit to the total mass of the atmosphere. Among these laws it may suffice here to mention the adiabatic law, used as already explained, to define a lower limit to that total mass. Although this adiabatic law fits well with the observed conditions at the surface of the earth, it gives too low gradients for the decrease of pressure, density, and temperature. Thus the resulting computed mass will be greater than the actual mass, as desired; but, unhappily, it comes out so great as to leave a wide range of possibilities open for the play of additional hypotheses. This upper limit is, in fact, about one twelve-hundredth of the mass of the entire earth. Hence, from the lines of reasoning here indicated we are able to state only that the actual mass of the atmosphere is greater than one-millionth and less than one twelve-hundredth of the entire mass of the earth.

Such then are the salient steps in the historical procession of ideas concerning the atmosphere down to the middle of the nineteenth century, when, with the advent of the kinetic theory of gases and with the advent of the comprehensive doctrine of energy, a new impulse was given to the study of geophysics, including all branches of meteorology. But the kinetic theory of gases in conferring a considerable freedom of individual action on the molecules cast doubt on the validity of our earlier notions of atmospheric fluidity. Accumulating observational data have also shown the problems of the atmosphere to be far more complex than they appeared to be to our predecessors of the earlier half of the nineteenth century.

About forty years ago, approaching the subject from the points of view furnished by the kinetic theory, Dr. G. Johnstone Stoney showed with a high degree of probability that there could be no such thing as a smooth upper limiting surface to the atmosphere, even if it were not subject to motional disturbances arising from the heat of the sun, for the relief from pressure of the molecules in the vicinity of such a surface would permit them to roam about, like a swarm of atomic meteorites, subject only to their intrinsic energies and to the attraction of the earth. It was shown also that this freedom of action of the molecules, if long continued, would result in the selection of particular gases appropriate to the gravitational attraction of any planet; since, in the long run, gases whose molecular velocities are higher than a certain critical value would be able to escape, while those whose molecular velocities are below that critical value would be forced to remain on the planet. Thus, at the time this ingenious and fruitful theory was advanced, it appeared to account satisfactorily for the observed presence of certain gases only

in the atmosphere of the earth, and for the absence of an atmosphere on the moon, the gravitational attraction on the latter being insufficient to hold such a medium. More recently, however, the veteran author has himself questioned the validity of some points in his own and in later applications of the kinetic theory of gases to the problem of the conservation and dissipation of planetary atmospheres. But time does not permit entering into the details of this interesting and intricate subject on this occasion. To do so would require another chapter in the history of geophysical science. I may fittingly close by quoting an aphorism laid down by Dr. Stoney in his latest contribution to this field of inquiry, an aphorism which should be kept in mind by investigators in general as well as by meteorologists in particular. In pointing out the dangers which beset the use of theories and hypotheses he says, "Theories are suppositions we hope to be true; hypotheses are suppositions we expect to be useful."

What, then, in a summary way, may we affirm, with due Socratic caution, concerning our atmosphere? It is a mixture of gases, consisting mainly of nitrogen and oxygen, but with small proportions also of argon, helium, hydrogen, krypton, neon, and xenon, and with traces of carbon dioxid and ammonia. This mixture of gases must be visualized as a myriad, though not countless myriad, of missiles which are flying about individually in the liveliest manner, but with easily measurable finite velocities. They collide with one another astonishingly frequently under such conditions as obtain in this room, for example; but their masses are so small that the bombardment by millions of millions of them per second on the delicate tissues of the eye works no perceptible harm. Their weight, or the gravitational pull of the earth on their aggregate, slightly modified by centrifugal forces, gives rise to what we call the pressure of the atmosphere as measured by the barometer. The degree of their internal conflict and the closeness of approach to one another give rise to what we call the temperature and the density of the air. This molecular aggregation, or medium, extends upward to a height whose value in any direction can not be definitely assigned at present, although we may say with a high degree of probability that this height has an upper limit in the Laplacian envelope already described. The mass of this medium is sensibly constant, although it seemed quite probable that there goes on an appreciable exchange of molecules between the terrestrial and the cosmic supplies. The amount of this mass is certainly greater than the millionth part of the total mass of the earth, and it is certainly less, probably very much less, than the twelve-hundredth part of the earth's mass. We may also state with practical

certainty that the principal phenomena of applied meteorology—the hot and cold waves and the wet and dry seasons; or, in short, the winds and the weather"—are all confined within a height of 15 to 20 miles.

In closing this brief may I not call your attention to the peculiarly humanistic aspects of the science of meteorology? Great minds from Job to St. John, from Archimedes and Aristotle to Newton and Laplace, to Helnholtz and Kelvin, have contributed to the ideas and have elaborated the theories that belong to this subject. It is a subject which has a literature as well as a science, and both of these are worthy of attention from all those who can rise above the level of a merely verbal interpretation of the universe of which we form a part. Meteorology deals with phenomena close at hand. It should contribute daily to the intellectual and the moral uplift as well as to the physical comfort of mankind. It has helped greatly in the past to substitute fact for fancy, confidence for fear, and rationality for superstition; and we may confidently expect that in the future it will contribute still more to the advancement of our race.

(V) MISLEADING NAMES FOR WINDS.

By Prof. Dr. C. KASSNER. (Berlin, Dec. 22, 1909.)

Together with various home customs and usages of daily life often introduced by emigrants and sailors into far distant lands, there come also concepts connected with the weather of the home locality. This explains the fact that many weather features bear the same name in widely separated lands between which there is ready communication and active commercial intercourse. This identity of names is all right so long as the weather phenomena concerned are exactly the same, but it introduces serious errors when the phenomena have but a single characteristic in common while they are physically quite distinct in nature. Thus two winds, for example, may both be warm and yet be due to fundamentally different causes. The recent note[1] "What is the Chinook Wind?" presents a good example of this kind.

I would here cite some further cases where winds have their direction in common but differ considerably in other respects. Umlauft has contributed a long article[2] on the names of these winds, and Mohn and myself have written supplementary remarks to the same. According to Professor Mohn's communication the Faroe Islanders and the Icelanders call all easterly (northeast, east, southeast) winds "land-winds" and all westerly winds "sea-winds". Now these terms are quite inappropriate for the Faroes, and in Iceland they are suitable only for the west coast. Evidently the Norwegians have carried the names from the coast of Norway, where indeed east winds are land-winds and west winds are sea-winds, to Iceland and the Faroes where they have continued to use them in the usual way. The directions of the winds were similar in the different localities, but their dynamic origin and climatic significance went unheeded.

A quite analogous case in Algiers came to my attention when there in 1902. On one very hot day a cabman, who in common with many members of the "open air trades" had a very excellent knowledge of the Algerian climate, told me that the pleasantest wind of that city was the "Mistral". By this he understood a wind from the northwest, i. e., a wind from the sea, and in answer to my surprised query he assured me

[1] Abbe, C., in Monthly Weather Review, 1909, **37**: 131.

[2] Umlauft, Met. Zeitschr., 1894, 9–16.
Mohn, loc. cit., p. 102.
Kassner, loc. cit., p. 400.

that a northwest wind is called the "Mistral" in Algiers. It appears, therefore, that Frenchmen from southern France, on whose coast a cold, dry, unpleasant, descending wind is called "Mistral", have applied this name in Algiers to the local northwest wind which is indeed cool, but in this case is pleasant and also moist, since it comes from the sea.

On the Adriatic, "Maestral" (Italian, Maestro), also signifies a northwest wind which there, as in Algiers, is a pleasant wind, but it also designates any agreeable sea-wind in contrast to the land-wind. This latter conception of the Maestral as a sea-wind is so widespread on the coast of Dalmatia that there every cool wind from the south or southwest, i. e., from the sea, is called Maestro. An Austrian officer, long stationed there, informs me that this wind sets in at Zara about 10 a. m., at Spalato and Ragusa about 11 a. m. The opposite of the Maestro is the tramontana or mountain wind (Bergwind).

In ancient times, as in the present, many winds lost their original significance through transference to other localities. Thus Boreas was originally a mountain wind like its modern derivative the Bora, for the Boreas came from the mountains of Thrace or north of Greece. But Aristotle already introduced the second name, Aparktias, and Timosthenes shifted Boreas northeastward, or rather he located it between north-northeast and northeast, giving Aparktias as the wind blowing from the exact north, i. e., the wind blowing from the constellation of the Bear. Boreas continued to retain its meaning of the north wind even in those localities where no mountains lay to the north, or if so they were so distant that they could not have a climatic significance. Eratosthenes even shifted the Boreas to a point between northeast and east-northeast in the place of the Kaikias.

I shall close with this case of the Kaikias. Even the ancients derived the name from the river Káïkos in Mysia near Pergamon; while in modern Greek it is to-day called Graégos and is applied to a dry, warm, northeast or east wind. Aristotle introduced the ancient name as signifying a wind which blows from the quarter where the sun rises at the time of the summer solstice. I found that the river Káïkos does lie in exactly this direction from Athens; but the defective geographical knowledge of the ancient Greeks forbids the adoption of this fact in explanation of the name. I believe, rather, that the following hypothesis is the true one: As the ships from Chios or Smyrna emerged from the narrow channels upon the open sea they were frequently caught by the strong northeast wind; but at this point the valley of the Káïkos bears northeast. The sailors from Chios or Smyrna usually put in at the harbors of Atarneus in Mysia (the modern Dikeli) or of Mytilene. Aristotle spent the two

years 347 to 345 B. C. in residence at these two ports and, with his interest for natural phenomena, he had certainly often heard of and probably experienced the unpleasant northeast wind, an analogue of the wind from the Dardanelles. As he was drawing up his Classification of Winds he may have recalled this wind and named it after the river, or more probably called it by the name already in use by the sailors. But while the Káïkos of Asia Minor is a land-wind, it appears as a sea-wind in its new Greek home. Thus we have here an antique parallel to the above mentioned modern case of the Mistral.

The foregoing cases show that the mere name of a wind does not furnish unimpeachable testimony as to its direction, origin, and climatic significance, and they caution us against accepting offhand reports about the winds of foreign lands. The same remark applies to reported occurrences of the Sirocco in Mediterranean and Alpine lands.

(VI) UPPER AIR DATA FOR JULY, AUGUST, AND SEPTEMBER 1909.

By the Aerial Section—W. R. BLAIR in Charge.

About the middle of July, 1909, the installation of the storage battery was completed and power to run the kite reel on Sundays thus became available. Accordingly on Sunday the 18th and thereafter upper air observations at Mount Weather have been daily instead of daily except Sunday.

Of the 90 upper air observations made during this period, 34 were by means of captive balloons and 56 by means of kites. The means of the highest altitudes reached in the 34 balloon ascensions are, for July 2073, for August 2342, for September 1997, and for the period 2172 meters. Ten of the ascensions were made in July, 15 in August, and 9 in September. Similar means for the kite flights are, for July 2976, for August 2964, for September 2728, and for the period 2880 meters. The highest balloon ascension, 3552 meters, was made August 6, while the highest kite flight, 6813 meters, was made July 2.

The balloon ascension of August 6 is the station's highest so far; while the kite flight of July 2 is now the third highest yet attained, being 60 meters higher than that of September 30, 1908. The average height of balloon ascensions for this period is 100 meters more than for these three months of last year, while the average height of the kite flights is nearly 50 meters less.

The prevailing wind direction for the period was northwest and the mean wind velocity was 17.7 kilometers per hour, the latter being somewhat higher in July and September than in August. During the same months of last year the prevailing wind direction was southeast in July and September, northwest in August, and the mean velocity was 15.6 kilometers per hour.

It seems desirable to indicate on the isothermal charts the time at which maxima and minima of surface pressure occur. This will be done at the bottom of the chart. A small arrow (in red) pointing downward will indicate a maximum, while a similar arrow pointing upward will indicate a minimum. Incidentally, any arrow will point in the direction of the vertical component of the air's movement during the rise or fall of pressure just preceding it.

The barogram for the period is a rather smooth curve without any sharp maxima or minima. Well developed low pressure areas have, for

the most part, kept far to the north of Mount Weather, while high pressure areas of moderate or low intensity have lingered over this part of the country. Accompanying this pressure distribution the weather was unusually clear and the rainfall considerably below normal.

The almost uninterrupted rise and fall of the isotherms up to about the 1500-meter level is prominent on the isothermal charts (XXV to XXXI) for these three months. The general lowering and rising of the isotherms during periods of increasing and decreasing pressure respectively is apparent though less prominent than in the winter months when pressure changes are sharper.

On July 6 a slight barometric depression pushing in from the west was accompanied by dense fog (low cloud, the base of which was just below the mountain top) and a very little precipitation. This, no doubt, accounts for the isothermal condition found up to about the 2000-meter level. The top of the cloud layer was probably coincident with the base of the inversion layer found in the next few hundred meters.

Figs. 45, 46, and 47 show the mean hourly temperatures at the base kite station and at the valley stations for the period. Considerably greater daily range of temperature at the lower stations is especially noticeable. Comparison of these figures with figs. 1, 2, and 3, page 25 in part 1 of this volume (II) of the BULLETIN, shows that the mean daily range of temperature at both mountain and valley stations is greater for July and August and less for September than it was for these months last year. The minima are lower this year than last, while the maxima, with the exception of Trapp and Mount Weather, respectively, are higher in July and September, but lower in August. The total amount of rainfall in July and August of this year is less than one-third that for these three months last year, while their clear days number nearly twice as many this year as last. In September the rainfall is somewhat greater this year than it was last and the number of clear days less. The cloud observations for the period are tabulated below.

Month.	Number of days.			Mean cloudiness.
	Clear.	Partly cloudy.	Cloudy.	
July	16	12	3	3.8
August	13	11	7	4.5
September	14	9	7	4.4

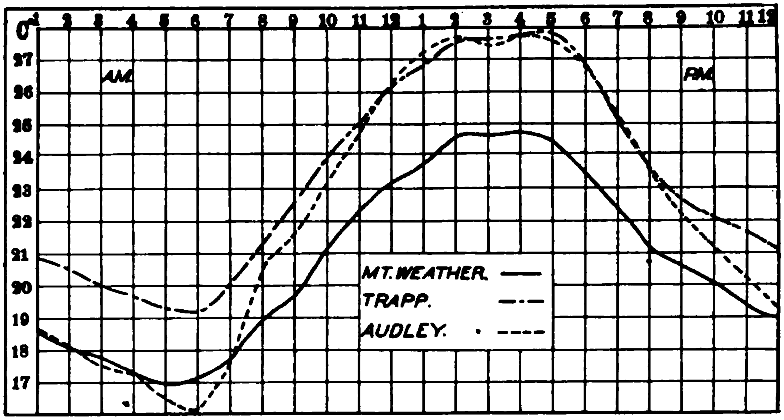


FIG. 45.—Mean hourly temperatures, July, 1909.

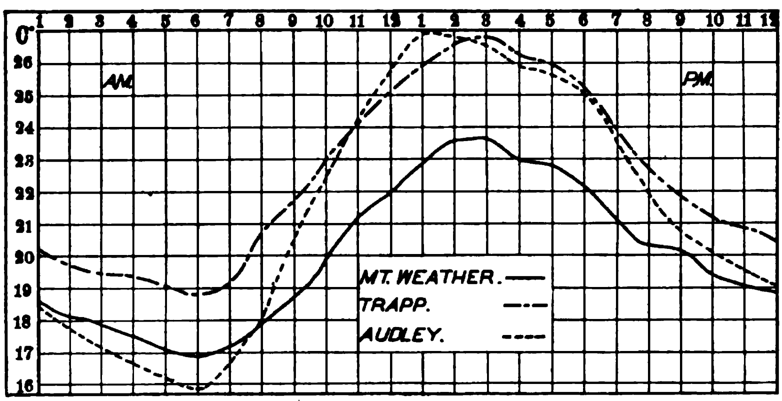


FIG. 46.—Mean hourly temperatures, August, 1909.

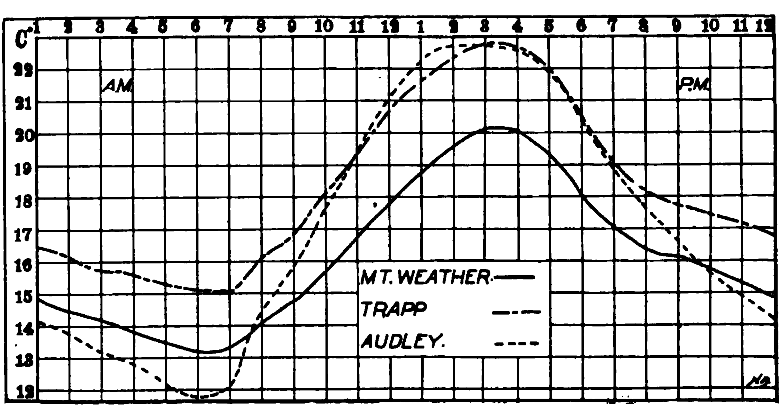


FIG. 47.—Mean hourly temperatures, September, 1909.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. July 1.	*mm.*	*°C.*	%		*m. p. s.*	*Meters.*	*mm.*	*°C.*	%		*m. p. s.*
8:35 a. m....	714.1	23.8	82	w.	4.0	526	714.1	23.8	82	w.	4.0
8:51 a. m....	714.0	23.8	82	w.	4.0	747	696.2	22.5	......	wnw.	....
8:58 a. m....	714.0	24.0	82	w.	4.0	1002	676.2	23.9	......	nw.	....
9:56 a. m....	713.8	25.1	78	wnw.	3.6	1240	658.0	22.6	......	nw.	....
10:52 a. m....	713.6	25.2	78	wnw.	3.6	914	682.9	25.0	......	nw.	....
11:57 a. m....	713.3	25.6	77	wnw.	3.1	526	713.3	25.6	77	wnw.	3.1

RESULTS OF CAPTIVE BALLOON ASCENSION.

July 1.											
3:40 p. m....	711.4	28.9	61	w.	2.2	526	711.4	28.9	61	w.	2.2
3:48 p. m....	711.3	28.8	62	w.	2.2	1541	634.2	23.1	......	wnw.	....
4:00 p. m....	711.2	29.3	62	w.	3.1	1128	664.6	24.7	......	wnw.	....
4:33 p. m....	711.1	29.6	58	w.	2.7	865	684.5	27.2	......	w.	....
4:48 p. m....	711.0	29.6	60	w.	2.2	526	711.0	29.6	60	w.	2.2

RESULTS OF KITE FLIGHTS.

July 2.											
6:40 a. m....	712.2	18.5	70	nw.	7.6	526	712.2	18.5	70	nw.	7.6
6:52 a. m....	712.2	18.5	72	wnw.	8.9	908	681.3	18.2	......	n.	....
7:00 a. m....	712.2	18.8	71	wnw.	8.9	1033	671.4	17.4	......	n.	....
7:06 a. m....	712.2	18.9	71	wnw.	8.9	1432	641.0	19.7	......	n.	....
7:43 a. m....	712.3	19.7	71	wnw.	8.5	2269	581.7	15.8	......	nnw.	....
8:10 a. m....	712.3	20.1	68	wnw.	8.9	2700	552.8	13.2	......	nnw.	....
8:31 a. m....	712.3	20.5	65	wnw.	8.9	3367	510.0	7.8	......	nnw.	....
8:56 a. m....	712.3	21.0	63	wnw.	8.5	4367	450.6	2.2	......	nnw.	....
9:21 a. m....	712.3	21.4	61	wnw.	8.0	4895	422.5	0.2	......	nnw.	....
10:28 a. m....	712.4	23.1	49	wnw.	6.7	5526	391.2	−2.9	......	nw.	....
10:58 a. m....	712.3	23.6	51	wnw.	6.7	5965	369.7	−6.5	......	nw.	....
11:50 a. m....	712.3	24.1	49	wnw.	6.7	6813	331.8	−10.9	......	nw.	....
12:14 p. m....	712.3	24.4	48	wnw.	6.7	5745	381.2	−3.8	......	nw.	....
1:44 p. m....	711.9	25.4	46	nw.	7.2	4856	425.8	0.3	......	nw.	....
2:00 p. m....	711.9	25.6	44	nw.	8.0	526	711.9	25.6	44	nw.	8.0

July 1.—Kite flight: Three kites were used; lifting surface, 24.3 sq. m. Wire out at the maximum altitude, 1500 m.

About 6/10 Ci.-St., from the northwest.

July 1.—Balloon ascension: One balloon was used; capacity, 31.1 cu. m. Wire out, 2,400 m.

About 3/10 Ci.-Cu. from the west-northwest. At 4:48 p. m. 1/10 Cu. from the west.

At 8 a. m. pressure was low over the St. Lawrence Valley and the Gulf States, and high over the Great Plains.

July 2.—Eleven kites were used; lifting surface, 70.8 sq. m. Wire out, 15300 m; at maximum altitude, 13500 m.

The sky was cloudless until noon. Thereafter 1/10 Ci.-St. from the west.

Low pressure was central over the Gulf of St. Lawrence. A second depression lay over southern Georgia. Pressure was relatively high south of Florida and over western Kansas.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909 July 3.	*mm.*	*°C.*	%		*m. p. s.*	*Meters.*	*mm.*	*°C.*	%		*m. p. s.*
6:31 a. m.	707.7	21.0	69	w.	10.3	526	707.7	21.0	69	w.	10.0
6:38 a. m.	707.7	21.0	69	w.	10.3	977	671.8	20.8	......	w.	....
6:55 a. m.	707.8	20.9	70	w.	9.8	1238	651.6	16.9	......	w.	....
7:15 a. m.	707.8	21.0	72	w.	7.6	1555	627.8	14.1	......	w.	....
7:38 a. m.	707.9	20.9	75	w.	5.8	2180	583.0	10.6	......	w.	....
8:25 a. m.	708.0	23.0	67	w.	8.9	1242	651.6	10.6	......	w.	....
8:40 a. m.	707.9	23.4	65	w.	11.6	526	707.9	23.4	65	w.	11.6

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

July 5.											
10:05 a. m.	719.2	17.8	48	w.	2.2	526	719.2	17.8	48	w.	2.2
10:15 a. m.	719.2	17.8	49	w.	1.8	2123	594.3	4.8	......	w.	....
10:44 a. m.	719.2	17.5	48	nw.	2.2	1692	625.9	6.2	......	w.	....
11:06 a. m.	719.2	18.7	51	nw.	2.2	1385	649.5	8.6	......	sw.	....
11:27 a. m.	719.2	19.6	49	w.	2.2	935	685.6	13.1	......	w.	....
11:37 a. m.	719.1	18.8	50	w.	2.7	526	719.1	18.8	50	w.	2.7
July 6.											
2:45 p. m.	714.9	16.4	100	ne.	2.7	526	714.9	16.4	100	ne.	2.7
2:57 p. m.	714.9	16.2	100	ne.	2.7	2439	572.4	20.4	......	nw.	....
3:20 p. m.	714.8	16.9	96	ene.	3.6	1816	614.9	17.3	......	nnw.	....
3:30 p. m.	714.8	16.6	97	ne.	3.6	1460	640.9	16.9	......	nnw.	....
3:39 p. m.	714.7	16.6	97	ene.	2.7	992	676.8	16.5	......	nne.	....
3:51 p. m.	714.6	16.6	96	ne.	2.7	526	714.6	16.6	96	ne.	2.7

July 3.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, at the maximum altitude, 4000 m.

About 9/10 St.-Cu., from the west, during the early part of the flight. Later these diminished to about 6/10, and about 3/10 Ci.-Cu. from the west.

At 8 a. m. a low of considerable energy was central over New England and a moderate high was central over Manitoba.

July 5.—One balloon was used; capacity, 31.1 cu. m. Wire out, 3000 m.

A few Ci. and a few Cu. from the west.

Pressure was relatively high over Virginia and West Virginia. Low pressure was central over Kansas.

July 6.—One balloon was used, capacity, 31.1 cu. m. Wire out, 2050 m.

Dense fog prevailed until 3:08 and from 3:25 to 3:38 p. m., light fog from 3:08 to 3:25 and after 3:38 p. m. Low St., moving with the surface wind, covered the sky.

Moderately high pressure was central over the Lake region and the south Atlantic seaboard. Pressure was relatively low over the Ohio Valley.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. July 7.	*mm.*	°*C.*	%		*m. p. s.*	*Meters.*	*mm.*	°*C.*	%		*m. p. s.*
11:15 a. m....	716.0	19.8	53	n.	4.5	526	716.0	19.8	53	n.	4.5
11:33 a. m....	716.1	21.0	56	n.	4.5	878	687.5	16.0	......	n.	....
12:48 p. m....	716.0	21.8	46	n.	4.5	1449	642.7	11.1	......	n.	....
1:50 p. m....	715.8	22.2	42	n.	4.5	1824	614.4	7.5	......	n.	....
2:29 p. m....	715.7	22.8	40	n.	4.9	2499	565.4	0.6	......	n.	....
3:04 p. m....	715.5	23.0	42	n.	3.6	3422	506.2	− 1.0	......	nnw.	....
3:43 p. m....	715.5	22.8	41	n.	4.9	3982	472.3	− 3.8	......	nnw.	....
4:00 p. m....	715.5	23.3	41	n.	4.5	526	715.5	23.3	41	n.	4.5

RESULTS OF CAPTIVE BALLOON ASCENSION.

Date and hour.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
July 8.											
10:36 a. m....	716.9	19.5	44	nnw.	3.1	526	716.9	19.5	44	nnw.	3.1
10:46 a. m....	716.9	19.6	44	nnw.	3.6	1833	614.9	11.2	......	nne.	....
11:07 a. m....	716.8	19.8	38	nnw.	3.6	1510	638.9	13.5	......	ne.	....
11:17 a. m....	716.8	19.8	37	nnw.	3.6	1148	666.7	15.3	......	nne.	....
11:22 a. m....	716.7	20.0	40	nnw.	3.1	824	692.4	17.0	......	n.	....
11:29 a. m....	716.7	20.2	40	nnw.	2.7	526	716.7	20.2	40	nnw.	2.7

RESULTS OF KITE FLIGHTS.

Date and hour.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
July 9.											
7:12 a. m....	716.2	17.0	46	e.	7.6	526	716.2	17.0	46	e.	7.6
7:19 a. m....	716.3	16.9	48	e.	7.6	754	697.5	17.8	......	e.	....
10:13 a. m....	716.9	19.2	55	e.	6.7	1107	669.9	17.1	......	e.	....
10:32 a. m....	717.0	19.6	56	e.	5.8	763	697.5	16.8	......	e.	....
10:37 a. m....	717.0	19.9	56	e.	5.8	526	717.0	19.9	56	e.	5.8

July 7.—Six kites were used; lifting surface, 43.2 sq. m. Wire out, at maximum altitude, 6500 m.

A few Cu. at the beginning, increased to 2/10 by the end of the flight.

Low pressure was central off the North Carolina coast. Pressure was high over the upper Lakes and the Gulf coast.

July 8.—One balloon was used; capacity, 31.1 cu. m. Wire out, 2000 m.

A few Ci. from the northwest.

At 8 a. m. pressure was moderately high over the Lake region, and low over Maine, Florida, and the middle Mississippi Valley.

July 9.—Three kites were used; lifting surface, 20.9 sq. m. Wire out, 2000 m.; at the maximum altitude 1800 m.

Light haze and Ci. clouds, the latter moving from the west and diminishing from 4/10 at the beginning to 1/10 at the close, were observed.

At 8 a. m. pressure was high over New York and low over Florida, Alaama, and Manitoba.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909. July 10.	*mm.*	*°C.*	*%*		*m. p. s.*	*Meters.*	*mm.*	*°C.*	*%*		*m. p. s.*
12:52 p.m....	719.2	22.6	68	se.	3.6	526	719.2	22.6	68	se.	3.6
1:04 p.m....	719.2	22.9	62	se.	3.6	766	699.6	18.6	......	sse.	......
1:37 p.m....	718.9	23.0	67	se.	4.0	1302	657.2	14.2	......	sse.	......
1:58 p.m....	718.7	24.2	62	s.	4.0	2082	599.2	9.7	......	s.	......
2:45 p.m....	718.5	24.1	57	se.	4.5	1561	637.2	13.6	......	s.	......
3:38 p.m....	718.3	24.2	49	sse.	3.6	1011	679.4	18.8	......	s.	......
3:48 p.m....	718.2	24.2	48	sse.	4.5	526	718.2	24.2	48	sse.	4.5
July 12.											
9:49 a.m....	714.3	21.0	75	se.	3:6	526	714.3	21.0	75	se.	3.6
10:00 a.m....	714.2	21.8	75	se.	4.0	822	690.4	22.1	......	sw.	......
11:04 a.m....	714.2	22.3	76	se.	3.6	1391	646.1	17.1	......	wsw.	......
12:46 p.m....	714.0	24.6	71	se.	3.6	1872	611.0	14.2	......	w.	......
1:04 p.m....	714.0	24.7	71	se.	3.1	2229	586.2	13.5	......	w.	......
1:45 p.m....	713.8	24.2	74	se.	3.6	2736	551.8	11.4	......	w.	......
2:54 p.m....	713.5	25.8	68	s.	3.6	3282	517.1	8.2	......	wnw.	......
3:48 p.m....	713.1	27.6	64	s.	2.7	2627	559.3	11.9	......	wnw.	......
4:13 p.m....	712.9	27.4	64	s.	2.7	1817	614.6	15.5	......	w.	......
4:23 p.m....	712.9	26.8	68	s.	3.6	904	682.9	21.7	......	sw.	......
4:40 p.m....	712.8	27.6	65	s.	3.6	526	712.8	27.6	65	s.	3.6
July 13.											
7:48 a.m....	713.3	22.4	71	wnw.	8.0	526	713.3	22.4	71	wnw.	8.0
7:58 a.m....	713.3	22.4	71	w.	8.0	881	684.8	20.5	......	w.	......
8:09 a.m....	713.3	22.6	70	w.	8.5	1358	648.0	18.5	......	w.	......
8:32 a.m....	713.5	22.7	74	w.	6.7	1740	620.3	18.0	......	wsw.	......
8:53 a.m....	713.6	23.2	74	wnw.	5.8	2167	590.0	15.0	......	wsw.	......
9:10 a.m....	713.6	23.7	72	wnw.	6.7	2723	551.9	9.9	......	wsw.	......
9:53 a.m....	713.6	21.6	88	nw.	6.3	2835	544.4	10.9	......	wsw.	......
10:28 a.m....	713.5	23.2	75	wnw.	5.4	3667	492.7	6.0	......	sw.	......
11:10 a.m....	713.4	24.1	76	wnw.	5.8	4438	448.5	1.5	......	wsw.	......
12:45 p.m....	713.6	25.4	70	wnw.	3.6	4049	470.7	2.8	......	wsw.	......
1:36 p.m....	713.3	26.2	71	wnw.	2.7	526	713.3	26.2	71	wsw.	2.7

July 10.—Four kites were used; lifting surface, 30.1 sq. m. Wire out, 3500 m.; at maximum altitude, 2000 m.

Ci. moving from the north-northwest and Cu. moving from the south-southeast covered 3/10 of the sky at the beginning, but by the end of the flight only a few Cu. remained. The head kite was in Cu. from 1:51 to 1:59 and at 2:22 p. m.

Low pressure was central north of Lake Superior. High pressure, central off the coast of southern New England, extended from New Brunswick to the Carolinas.

July 12.—Seven kites were used; lifting surface, 46.6 sq. m. Wire out, 5000 m.; at maximum altitude, 4500 m.

At the beginning 8/10 St.-Cu. from the west were observed. Light rain fell from 10:25 to 10:35 a. m. At 11:53 a. m. 4/10 A.-Cu. and 2/10 St.-Cu. were observed. At 1:20 p. m. 9/10 St.-Cu. were present and they gradually decreased to 4/10 by the end of flight. The altitude of the St.-Cu. was about 2000 m.

Low pressure was central over Lake Superior and pressure was high off the Georgia coast.

July 13.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, at maximum altitude, 7800 m.

Ci.-St. and A.-Cu., from the west-southwest, and St.-Cu. from the west, were visible in amounts decreasing from 10/10 at 9:45 to 4/10 at 10:30 a. m., and increasing to 9/10 by 11:00 a. m. Distant thunder was heard in the northwest at 9 a. m. Light rain fell from 9:08 to 9:15, and from 9:43 to 10:02 a. m. The head kite was in St.-Cu. at intervals from 11:14 a. m. until 12:10 p. m.

Low pressure was central over the lower St. Lawrence. Pressure was relatively high over Florida.

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. July 14.	mm.	°C.	%		m. p. s.	Meters.	mm.	°C.	%		m. p. s.
10:37 a. m....	715.9	23.6	69	nnw.	1.8	526	715.9	23.6	69	nnw.	1.8
11:00 a. m....	716.0	24.8	64	wnw.	2.7	2620	560.6	8.7	......	wsw.	....
11:23 a. m....	715.9	25.2	62	nne.	3.6	2207	589.0	11.5	......	wsw.	....
11:35 a. m....	715.9	25.4	64	se.	3.6	1873	612.6	14.0	......	sw.	....
11:45 a. m....	715.9	26.0	60	se.	2.7	1522	638.2	17.6	......	calm.	....
11:56 a. m....	715.8	25.4	59	e.	3.1	1004	680.0	18.6	......	e.	....
12:07 p. m....	715.8	25.0	62	se.	3.1	526	715.8	25.0	62	se.	3.1
July 15.											
3:01 p. m....	716.4	23.6	74	w.	3.1	526	716.4	23.6	74	w.	3.1
3:14 p. m....	716.4	22.8	78	w.	8.0	1994	603.9	13.5	......	sw.	....
3:40 p. m....	716.3	24.0	63	w.	4.5	1156	666.5	20.8	......	sw.	....
4:00 p. m....	716.2	25.9	54	wsw.	3.6	924	684.6	24.2	......	wsw.	....
4:03 p. m....	716.2	25.8	54	wsw.	3.1	526	716.2	25.8	54	wsw.	3.1

RESULTS OF KITE FLIGHTS.

July 16.											
9:54 a. m....	714.8	22.2	68	wsw.	5.8	526	714.8	22.2	68	wsw.	5.8
10:06 a. m....	....	22.5	67	wsw.	5.4	932	....	21.2	......	sw.	....
11:24 a. m....	....	23.6	69	sw.	5.4	2113	....	10.3	......	wsw.	....
12:04 p. m....	....	26.0	57	wsw.	5.8	3072	....	4.2	......	w.	....
12:28 p. m....	....	26.4	57	wsw.	6.3	3444	....	1.1	......	w.	....
12:53 p. m....	....	26.8	51	wsw.	6.7	4569	....	− 6.8	......	w.	....
1:34 p. m....	....	26.9	56	w.	4.9	5689	....	−13.4	......	w.	....
2:22 p. m....	....	28.0	48	wsw.	5.8	5137	....	− 8.8	......	w.	....
3:07 p. m....	....	28.8	44	wnw.	4.9	4396	....	− 4.4	......	w.	....
3:49 p. m....	....	28.4	50	w.	4.9	3172	....	3.9	......	w.	....
4:11 p. m....	....	26.9	57	wnw.	3.1	2435	....	10.6	......	w.	....
4:33 p. m....	....	26.8	57	nw.	4.5	1479	....	16.9	......	wnw.	....
4:49 p. m....	....	26.0	61	nw.	3.1	751	....	24.2	......	wnw.	....
4:55 p. m....	712.7	25.2	64	wnw.	4.0	526	712.7	25.2	64	wnw.	4.0

July 14.—One balloon was used; capacity, 31.1 cu. m. Wire out, 2500 m.

A.-Cu. from the west diminished from 5/10 at the beginning to a few at the close of the ascension. A few Cu. from the southeast were visible after 11:30 a. m.

The pressure, which was nearly uniform, was slightly lower east of the station and higher over Alabama.

July 15.—One balloon was used; capacity, 31.1 cu. m. Wire out, 2100 m.

About 9/10 St.-Cu. from the west. Light rain fell from 3:21 to 3:25 p. m.

Low pressure was central north of Lake Superior and pressure was relatively high off the south Atlantic coast.

July 16.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 7500 m.; at maximum altitude, 7400 m. Altitudes were determined from vertical angles.

St.-Cu. covered the sky until 11:30 a. m. Thereafter Ci., Ci.-Cu., A.-Cu., Cu., and St.-Cu. in amounts decreasing to 2/10 by 3 p. m. During the remainder of the flight Cu. covered 5/10 of the sky. The Ci. moved from the west-southwest; other clouds from the west. Very light rain fell at intervals until 11:20 a. m. At 3 p. m. the altitude of the Cu. was about 2100 m.

Low pressure was central north of Lake Ontario. Pressure was high off the south Atlantic coast and over the Dakotas.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. July 17.	mm.	°C.	%		m. p. s.	Meters.	mm.	°C.	%		m. p. s.
6:47 a. m.	715.5	19.4	74	wnw.	4.5	526	715.5	19.4	74	wnw.	4.5
6:57 a. m.	715.5	19.4	76	wnw.	4.9	950	....	16.5	......	nw.	....
7:12 a. m.	715.5	19.6	76	wnw.	4.9	1474	....	11.4	......	wnw.	....
7:28 a. m.	715.5	19.8	76	wnw.	4.9	2047	597.4	6.0	......	wnw.	....
7:42 a. m.	715.6	20.2	72	wnw.	4.9	2359	575.5	5.0	......	wnw.	....
7:54 a. m.	715.6	20.3	72	wnw.	5.4	2391	573.3	7.7	......	wnw.	....
8:50 a. m.	715.5	21.8	67	w.	4.9	2716	551.4	5.2	......	wnw.	....
10:05 a. m.	715.5	22.8	55	wnw.	8.5	1918	607.8	10.8	......	wnw.	....
10:14 a. m.	715.5	22.8	55	wnw.	9.8	1864	611.7	9.8	......	wnw.	....
10:39 a. m.	715.5	23.4	52	wnw.	8.0	834	....	17.3	......	wnw.	....
10:53 a. m.	715.5	22.6	55	wnw.	9.8	526	715.5	22.6	55	wnw.	9.8
July 18.											
7:08 a. m.	716.0	18.6	69	w.	5.8	526	716.0	18.6	69	w.	5.8
7:19 a. m.	716.0	19.0	68	w.	6.3	910	684.7	15.5	......	w.	....
7:34 a. m.	716.0	19.2	68	w.	6.3	1419	644.7	11.4	......	wnw.	....
7:55 a. m.	716.0	19.5	66	w.	5.8	1649	627.3	12.6	......	wnw.	....
8:21 a. m.	715.8	20.0	65	w.	5.4	2515	565.1	6.0	......	wnw.	....
8:52 a. m.	715.7	20.6	62	wsw.	6.3	3247	517.0	1.4	......	w.	....
9:31 a. m.	715.6	21.4	56	wsw.	7.2	4061	467.8	− 2.7	......	w.	....
10:06 a. m.	715.6	22.6	64	w.	6.3	3356	511.4	2.7	......	wnw.	....
10:33 a. m.	715.5	23.2	54	w.	4.9	2856	543.2	4.2	......	wnw.	....
11:00 a. m.	715.4	23.6	49	w.	6.3	1926	....	8.4	......	wnw.	....
11:52 a. m.	715.0	24.6	47	w.	8.0	936	....	19.3	......	w.	....
12:02 p. m.	715.0	24.6	42	w.	10.7	526	715.0	24.6	42	w.	10.7
July 19.											
7:28 a. m.	717.5	13.2	67	wnw.	8.9	526	717.5	13.2	67	wnw.	8.9
7:33 a. m.	717.6	13.4	65	wnw.	9.4	927	....	9.8	......	nw.	....
7:45 a. m.	717.6	13.8	65	nw.	11.2	1357	....	7.2	......	nw.	....
8:07 a. m.	717.6	14.2	64	nw.	9.4	2212	....	2.1	......	nw.	....
9:42 a. m.	717.8	16.6	54	nw.	10.3	526	717.8	16.6	54	nw.	10.3

July 17.—Five kites were used; lifting surface, 33.5 sq. m. Wire out, 4850 m.; at maximum altitude, 4600 m.

From 1/10 to 5/10 Cu. from the west-northwest after 8 a. m.

A low was central over the Gulf of St. Lawrence. High pressure prevailed over the upper Mississippi Valley.

July 18.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 5000 m.; at maximum altitude, 4600 m.

From 2/10 to 3/10 Ci. from the west-northwest during the entire flight. A few Cu. moving from the west appeared about 9 a. m., and had increased to 2/10 by the end of the flight. From 3/10 to 4/10 A.-Cu. from the west after 11:30 a. m.

Low pressure was central over Ontario and high pressure over Lake Superior, with another very moderate high over northern Alabama.

July 19.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 3000 m., at maximum altitude; a few Cu. moving from the northwest.

Low pressure was central over New Hampshire and high pressure was central over Michigan.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. July 20.	mm.	°C.	%		m. p. s.	Meters.	mm.	°C.	%		m. p. s.
7:58 a. m....	722.8	14.8	60	nnw.	4.9	526	722.8	14.8	60	nnw.	4.9
8:13 a. m....	722.8	15.0	58	nnw.	4.9	904	691.4	14.6	......	n.	....
8:46 a. m....	723.0	15.6	59	wnw.	4.9	1508	643.5	10.5	......	nne.	....
9:00 a. m....	723.0	16.0	61	nw.	4.5	1724	627.0	9.2	......	nne.	....
9:14 a. m....	723.0	16.2	59	nnw.	4.5	1939	611.0	7.5	......	n.	....
10:04 a. m....	723.1	18.2	57	nw.	3.1	2387	579.0	4.7	......	n.	....
10:58. a. m...	723.1	19.8	45	ne.	2.7	2715	556.6	6.0	......	n.	....
11:06 a. m....	723.1	20.2	43	ne.	2.7	2370	580.6	4.6	......	nne.	....
11:17 a. m....	723.1	20.4	43	n.	3.6	2125	598.2	5.8	......	nne.	....
11:27 a. m....	723.1	20.5	41	n.	3.6	1518	643.5	10.9	......	n.	....
11:33 a. m....	723.1	19.8	45	n.	3.1	990	685.1	15.4	......	n.	....
11:42 a. m....	720.1	20.0	45	n.	3.6	526	723.1	20.0	45	n.	3.6

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

July 21.											
1:16 p. m....	721.3	24.4	37	wnw.	2.2	526	721.3	24.4	37	wnw.	2.2
1:39 p. m....	721.1	24.1	37	nw.	3.1	2676	561.0	10.2	......	nw.	....
1:54 p. m....	721.0	24.6	36	w.	2.7	2206	593.0	11.4	......	w.	....
2:07 p. m....	721.0	25.2	36	wnw.	3.6	1371	654.2	17.4	......	wnw.	....
2:28 p. m....	720.9	24.2	37	wnw.	2.7	1017	681.5	20.6	......	wnw.	....
2:36 p. m....	720.8	24.4	37	wnw.	2.2	526	720.8	24.4	37	wnw.	2.2

July 20.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 3800 m.; at maximum altitude, 3000 m.

The sky was cloudless until 9:50 a. m., when a few Cu., moving from the north, appeared. These increased to 1/10 toward the close of the flight. The head kite was obscured from 11:01 to 11:05 a. m

A low was central off the Maine coast. High pressure prevailed over the Ohio Valley.

July 21.—One balloon was used; capacity 31.1 cu. m. Wire out, 2500 m.; 8/10 A.-St., from the northwest.

Centers of high pressure were over West Virginia and New York. Areas of low pressure were central over North Dakota and off the coast of Texas.

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909 July 22.	mm.	°C.	%		m. p. s.	Meters.	mm.	°C.	%		m. p. s.
12:59 p. m....	716.3	23.8	64	se.	4.0	526	716.3	23.8	64	se.	4.0
1:16 p. m....	716.2	23.4	68	ese.	4.0	2127	594.8	14.1	......	w.	....
1:41 p. m....	716.1	23.4	66	se.	4.0	1351	651.2	18.7	......	sw.	....
2:00 p. m....	716.0	22.7	75	se.	4.0	526	716.0	22.7	75	se.	4.0

RESULTS OF KITE FLIGHTS.

Date and hour.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
July 22.											
3:17 p. m....	715.2	22.0	76	se.	6.7	526	715.2	22.0	76	se.	6.7
3:28 p. m....	715.1	21.9	74	se.	5.4	782	694.3	17.6	......	se.	....
3:53 p. m....	714.9	22.6	70	ese.	8.0	1021	675.2	21.3	......	sse.	....
5:00 p. m....	714.4	21.6	76	se.	7.2	1802	615.4	12.6	......	ssw.	....
5:25 p. m....	714.4	21.4	73	se.	7.6	1184	661.8	18.2	......	s.	....
5:39 p. m....	714.4	21.0	77	se.	6.7	796	692.4	16.3	......	sse.	....
5:47 p. m....	714.4	21.0	77	se.	5.8	526	714.4	21.0	77	se.	5.8
July 23.											
10:41 a. m....	708.6	19.8	98	wsw.	4.9	526	708.6	19.8	98	wsw.	4.9
10:49 a. m....	708.6	20.0	97	wsw.	4.9	833	683.8	18.6	......	wnw.	....
11:02 a. m....	708.6	20.9	94	wsw.	4.5	1270	649.8	15.1	......	w.	....
11:17 a. m....	708.6	22.4	79	sw.	4.9	1779	611.9	10.6	......	w.	....
11:46 a. m....	708.6	21.5	92	sw.	2.2	2148	585.4	7.9	......	wsw.	....
11:56 a. m....	708.6	21.6	92	sw.	2.2	2518	560.0	6.9	......	wsw.	....
12:07 p. m....	708.6	21.6	92	ssw.	1.8	2662	550.3	8.2	......	wsw.	....
12:14 p. m....	708.5	21.6	92	ssw.	1.8	3215	514.3	2.0	......	sw.	....
12:22 p. m....	708.5	22.8	87	s.	1.8	2780	542.5	4.5	......	wsw.	....
12:25 p. m....	708.5	22.8	87	s.	1.8	2750	544.4	4.1	......	wsw.	....
12:45 p. m....	708.4	24.0	85	s.	3.1	2273	576.8	8.0	......	wsw.	....
12:53 p. m....	708.3	24.0	85	s.	3.1	2151	585.4	7.9	......	wsw.	....
1:15 p. m....	708.3	23.6	73	s.	4.5	1553	628.4	11.9	......	w.	....
1:32 p. m....	708.2	25.0	66	sw.	3.6	1051	666.6	17.9	......	w.	....
1:45 p. m....	708.1	25.2	71	sw.	3.6	526	708.1	25.2	71	sw.	3.6

July 22.—Balloon ascension: One balloon was used; capacity, 31.1 cu. m. Wire out, 2400 m.

The sky was covered with St.-Cu., from the north-northwest.

Kite flight: Four kites were used; lifting surface, 25.2 sq. m. Wire out, 3460 m.; at maximum altitude, 2100 m.

From 7/10 to 9/10 Ci.-Cu., A.-Cu. and St.-Cu., from the northwest. A few low St.-Cu., moving from the southeast, were observed between 4 and 5:15 p. m.

At 8 a. m. low pressure was central over Michigan, with a shallow secondary depression over western Virginia. Pressure was high along the Atlantic coast and over the Gulf States.

July 23.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5000 m., at maximum altitude.

From 2/10 to 10/10 St. from the west-southwest at the beginning of the flight and shifting to southwest. From 2/10 to 7/10 A.-Cu. from the west from 10:54 to 11:53 a. m.

From 1/10 to 6/10 Cu. from the southwest after 12:53 p. m.

The head kite was obscured by clouds at intervals from 10:44 a. m. to 12:25 p. m.

Low pressure was central over the lower Lakes and high pressure extended from Manitoba to Kansas.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.											
July 24.	*mm.*	*°C.*	*%*		*m. p. s.*	*Meters.*	*mm.*	*°C.*	*%*		*m. p. s.*
11:00 a. m....	714.6	18.4	51	nw.	13.0	526	714.6	18.4	51	nw.	13.0
11:09 a. m....	714.6	18.8	50	wnw.	13.4	894	684.5	13.5	......	nw.	....
11:45 a. m....	715.0	19.6	48	wnw.	13.4	1738	618.7	8.4	......	nw.	....
12:28 p. m....	715.1	20.3	42	wnw.	11.6	2039	596.7	7.9	......	nw.	....
1.07 p. m....	715.2	21.3	42	wnw.	9.8	2351	575.0	5.0	......	nw.	....
1:22 p. m....	715.2	21.2	43	wnw.	11.2	1854	611.0	4.5	......	nw.	....
1:43 p. m....	715.3	22.3	42	wnw.	9.8	1287	654.2	10.4	......	nw.	....
2.01: p. m...	715.3	22.2	41	wnw.	9.4	777	694.9	16.8	......	nw.	....
2:13 p. m....	715.3	22.6	42	wnw.	10.7	526	715.3	22.6	42	wnw.	10.7
July 25.											
8:05 a. m....	720.6	18.4	67	wnw.	6.7	526	720.6	18.4	67	wnw.	6.7
8:17 a. m....	720.6	18.2	67	wnw.	6.7	815	696.7	15.4	......	wnw.	....
9:00 a. m....	720.6	19.6	64	wnw.	6.7	1320	656.6	13.6	......	nw.	....
9:22 a. m....	720.6	20.4	59	wnw.	6.7	1880	614.0	7.4	......	wnw.	....
10:10 a. m....	720.7	21.0	53	wnw.	6.7	2232	588.8	5.2	......	wnw.	....
10:42 a. m....	720.7	21.8	50	nw.	7.2	2505	569.4	2.2	......	wnw.	....
10:59 a. m....	720.7	22.1	45	nw.	5.4	2165	593.4	3.9	......	wnw.	....
11:15 a. m....	720.7	22.6	44	nw.	6.3	1276	660.4	12.8	......	nw.	....
11:40 a. m....	720.6	23.0	41	wnw.	8.9	842	694.8	18.2	......	wnw.	....
11:47 a. m....	720.6	23.2	41	wnw.	8.5	526	720.6	23.2	41	wnw.	8.5

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

July 26.											
1:25 p. m....	720.5	25.8	44	ssw.	4.0	526	720.5	25.8	44	ssw.	4.0
1:35 p. m....	720.4	26.5	42	ssw.	3.6	1448	648.0	16.9	......	sw.	....
1:54 p. m....	720.2	26.5	40	s.	3.6	1029	680.1	20.2	......	ssw.	....
2:08 p. m....	720.1	26.6	39	s.	4.0	882	691.5	21.9	......	s.	....
2:24 p. m....	719.9	25.3	43	s.	4.0	526	719.9	25.3	43	s.	4.0

July 24.—Three kites were used; lifting surface, 17.1 sq. m. Wire out, 4830 m.; at maximum altitude, 4300 m.

Less than 1/10 Cu. from the northwest.

Low pressure was central over the upper St. Lawrence. Pressure was high over the Mississippi Valley and east of Florida.

July 25.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 4880 m.; at maximum altitude, 3650 m.

St.-Cu. moving from the west-northwest, and A.-Cu. and Cu. from the northwest, in amounts ranging from few to 2/10.

Low pressure was central over the lower St. Lawrence; high pressure over the Ohio Valley.

July 26.—One balloon was used; capacity, 25.6 cu. m. Wire out, 1650 m.

About 2/10 Ci. from the west and 6/10 Cu. from the southwest were observed.

High pressure was central over Maryland and pressure was low over the Rocky Mountain districts.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.											
July 27.	mm.	°C.	%		m. p. s.	Meters.	mm.	°C.	%		m. p. s.
7:54 a. m....	719.5	20.4	72	wsw.	4.0	526	719.5	20.4	72	wsw.	4.0
8:34 a. m...	719.8	20.6	74	wsw.	5.4	1313	656.6	14.1	......	s.	....
8:57 a. m....	719.7	21.4	73	sw.	3.6	1850	616.0	9.5	......	s.	....
9:48 a. m...	719.6	23.6	64	wsw.	1.8	2435	573.3	3.3	......	s.	....
11:08 a. m....	719.5	24.9	57	s.	2.2	1852	616.0	7.8	......	s.	....
11:17 a. m....	719.4	25.3	55	se.	2.7	1388	650.9	13.2	......	s.	....
11:25 a. m....	719.3	25.4	52	se.	2.2	876	691.0	18.8	......	s.	....
11:38 a. m....	719.2	25.9	53	sse.	3.1	526	719.2	25.9	53	sse.	3.1
July 28.											
6:35 p. m....	720.0	25.0	57	ese.	3.6	526	720.0	25.0	57	ese.	3.6
6:50 p. m....	720.0	25.0	63	ese.	3.6	930	687.6	21.4	......	se.	....
7:18 p. m....	720.0	24.2	66	se.	3.6	1322	657.0	18.7	......	sse.	....
7:38 p. m....	720.1	23.6	70	se.	3.1	1463	646.0	16.0	......	s.	....
7:48 p. m....	720.1	23.6	70	se.	3.1	1220	664.7	17.5	......	s.	....
7:59 p. m....	720.1	23.3	70	se.	3.1	904	689.5	20.0	......	se.	....
8:07 p. m....	720.0	23.2	71	ese.	3.6	526	720.0	23.2	71	ese.	3.6

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

July 29.											
2:12 p. m....	718.1	31.8	47	s.	2.7	526	718.1	31.8	47	s.	2.7
2:26 p. m....	718.0	29.1	53	nw.	3.1	1740	625.0	16.3	......	w.	....
2:42 p. m....	717.9	26.3	66	w.	5.4	1302	657.0	19.9	......	wnw.	....
2:45 p. m....	717.9	26.3	67	w.	5.4	955	683.7	22.1	......	wnw.	....
3:01 p. m....	717.9	26.6	68	nw.	3.6	526	717.9	26.6	68	nw.	3.6

July 27.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 3700 m.; at maximum altitude, 3460 m.

A.-Cu. from the west and St.-Cu. from the south-southeast nearly covered the sky. At intervals from 9:40 until 10:55 a. m. the two upper kites were hidden by passing St.-Cu., whose bases lay at an altitude of about 2200 m.

Low pressure was central over the Gulf of St. Lawrence. A shallow second depression lay over western North Carolina.

Pressure was high over the Middle Atlantic States.

July 28.—Three kites were used; lifting surface, 24.3 sq. m. Wire out, 2,500 m.; at maximum altitude, 1500 m.

A few Cu. were visible from the southeast.

High pressure was central off the middle Atlantic coast and low over Kansas.

July 29.—One balloon was used; capacity, 25.6 cu m. Wire out, 1750 m.

The sky was practically overcast during the entire ascension. Cloudiness consisted of from 7/10 to 9/10 Cu. and from 1/10 to 2/10 Cu.-N. from the west-northwest. A thunderstorm was observed in the west.

Pressure was high over Georgia and low over Lake Superior.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m. Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	At different heights above sea. Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. July 30.	mm.	°C.	%		m. p. s.	Meters.	mm.	°C.	%		m. p. s.
7:18 a. m....	715.4	22.8	77	wnw.	7.6	526	715.4	22.8	77	wnw.	7.6
7:27 a. m....	715.4	23.0	76	wnw.	7.2	872	687.7	22.5	......	wnw.	....
7:49 a. m....	715.5	23.6	75	wnw.	6.7	997	678.1	23.6	......	nw.	....
8:22 a. m....	715.6	23.2	78	wnw.	7.2	1320	653.3	20.5	......	nw.	....
9:46 a. m....	715.5	26.6	67	wnw.	7.2	1759	621.3	17.1	......	wnw.	....
9:54 a. m....	715.5	27.1	65	wnw.	7.2	1326	653.3	22.3	......	wnw.	....
10:00 a. m....	715.5	26.8	65	nw.	7.2	1074	672.4	24.7	......	wnw.	....
10:28 a. m....	715.4	27.4	65	wnw.	6.7	780	695.3	23.9	......	wnw.	....
10:37 a. m....	715.4	27.6	63	wnw.	7.6	526	715.4	27.6	63	wnw.	7.6

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Date and hour.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
July 31.											
7:32 a. m....	714.1	22.2	78	e.	3.1	526	714.1	22.2	78	e.	3.1
7:43 a. m....	714.1	22.2	78	e.	2.7	1735	620.7	16.1	......	wnw.	....
8:05 a. m....	714.1	23.0	73	ne.	1.8	1402	645.5	18.1	......	nnw.	....
8:14 a. m....	714.1	23.2	68	e.	1.8	977	678.0	20.2	......	ese.	....
8:25 a. m....	714.1	22.8	70	ne.	1.8	526	714.1	22.8	70	ne.	1.8
Aug. 1.											
7:26 a. m....	715.7	20.0	98	ne.	0.9	526	715.7	20.0	98	ne.	0.9
7:35 a. m....	715.7	20.3	99	e.	0.9	1422	645.0	17.1	......	ese.	....
7:44 a. m....	715.8	20.6	98	calm.	0.0	928	683.2	17.9	......	se.	....
8:08 a. m....	715.8	20.4	98	n.	1.8	526	715.8	20.4	98	n.	1.8

RESULTS OF KITE FLIGHTS.

Date and hour.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
Aug. 2.											
9:17 a. m....	720.6	20.4	50	e.	5.4	526	720.6	20.4	50	e.	5.4
9:37 a. m....	720.6	21.0	53	e.	4.9	925	688.1	17.4	......	e.	....
11:34 a. m....	721.0	22.9	54	e.	5.4	1260	661.4	13.9	......	e.	....
12:03 p. m....	721.0	23.1	51	ese.	4.0	811	697.7	18.9	......	ese.	....
2:23 p. m....	721.0	23.8	52	e.	5.8	526	721.0	23.8	52	e.	5.8

July 30.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 4500 m.; at maximum altitude, 3100 m.

From 1/10 to 6/10 A.-Cu. until 9:30 a. m. Thereafter from 3/10 to 1/10 Ci.-St. and Cu. were observed. All clouds were moving from the west.

Low pressure was central over New Brunswick. Pressure was high over the Gulf States.

July 31.—One balloon was used; capacity, 25.6 cu. m. Wire out, 1775 m.

From 8/10 to 10/10 St. from the west-northwest. Light rain fell from 7:30 to 7:32 a. m. The balloon was in the base of the St. at the highest altitude.

High pressure was central over Florida and low over the Gulf of St. Lawrence.

August 1.—One balloon was used; capacity, 25.6 cu. m. Wire out, 1550 m.

Light fog and 10/10 St. from the east prevailed until 7:58 a. m., after which there was dense fog until the close of the ascension.

Pressure was low over Tennessee and North Carolina and high over Ontario.

August 2.—Four kites were used; lifting surface, 31.1 sq. m. Wire out, 2000 m.; at maximum altitude, 1200 m.

At the beginning a few A.-St. with no apparent motion. At 11:26 a. m a few Cu. from the east. The A.-St. increased to 4/10 and the Cu. to 6/10 by the end of the flight.

High pressure was central over Vermont and pressure was relatively low over western North Carolina.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909.											
Aug. 3.	*mm.*	° *C.*	%		*m. p. s.*	*Meters.*	*mm.*	° *C.*	%		*m. p. s.*
7:04 a. m.	724.2	15.7	80	e.	4.5	526	724.2	15.7	80	e.	4.5
7:10 a. m.	724.2	15.6	79	e.	5.4	870	695.5	14.0	......	e.	....
7:29 a. m.	724.2	15.8	77	e.	4.5	1225	666.8	12.9	......	e.	....
7:54 a. m.	724.2	17.0	75	e.	4.5	1591	638.6	11.0	......	e.	....
8:19 a. m.	724.2	17.7	73	e.	4.5	1768	625.3	10.1	......	e.	....
9:52 a. m.	724.2	19.0	66	e.	5.8	2134	598.8	8.5	......	e.	....
10:17 a. m.	724.2	18.8	59	e.	7.2	2018	607.1	8.0	......	e.	....
10:31 a. m.	724.2	20.0	56	e.	6.3	1794	623.4	8.5	......	e.	....
10:46 a. m.	724.2	20.0	58	e.	5.1	1422	651.6	9.5	......	e.	....
11:00 a. m.	724.2	19.6	55	e.	5.6	919	691.7	13.9	......	e.	....
11:10 a. m.	724.2	20.1	57	e.	5.8	804	701.2	16.1	......	e.	....
11:15 a. m.	724.2	20.2	54	e.	6.3	526	724.2	20.2	54	e.	6.3

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Aug. 4.											
1:40 p. m.	719.5	22.8	51	nne.	1.8	526	719.5	22.8	51	nne.	1.8
2:21 p. m.	719.3	21.6	54	ese.	1.3	2081	598.7	7.3	......	wsw.	....
2:41 p. m.	719.1	22.7	53	nnw.	1.3	1690	627.4	10.2	......	sw.	....
2:56 p. m.	719.0	22.8	52	calm.	0.0	1363	652.2	13.7	......	calm.	....
3:03 p. m.	719.0	23.2	50	calm.	0.0	949	684.7	16.3	......	calm.	....
3:12 p. m.	718.9	23.2	47	w.	1.3	526	718.9	23.2	47	w.	1.3
Aug. 5.											
1:33 p. m.	716.2	26.0	58	ese.	1.8	526	716.2	26.0	58	ese.	1.8
1:50 p. m.	716.1	24.8	61	se.	1.8	1867	612.9	12.9	......	sw.	....
2:08 p. m.	716.0	23.6	69	ene.	2.2	526	716.0	23.6	69	ene.	2.2
2d ascension.											
5:51 p. m.	715.4	21.3	73	sse.	1.8	526	715.4	21.3	73	sse.	1.8
6:03 p. m.	715.4	21.9	73	s.	1.8	1505	638.7	16.6	......	calm.	....
6:14 p. m.	715.4	21.8	70	sw.	1.8	2203	587.7	10.0	......	nw.	....
6:20 p. m.	715.4	21.6	69	sw.	2.2	1684	624.9	12.4	......	nw.	....
6:49 p. m.	715.5	21.3	65	wnw.	1.8	1182	663.1	16.2	......	nw.	....
7:01 p. m.	715.5	21.4	61	wnw.	1.8	844	689.8	19.7	......	nw.	....
7:13 p. m.	715.6	21.2	64	wnw.	1.8	526	715.6	21.2	64	wnw.	1.8

August 3.—Six kites were used; lifting surface, 38.3 sq. m. Wire out, 4200 m.; at maximum altitude, 3400 m.

At the beginning of the flight 3/10 Ci. from the south-southwest and 4/10 A.-Cu. from the south were observed. The Ci. increased to 7/10 at 8:30 a. m. and decreased rapidly after 10 a. m. The A. -Cu. had disappeared by 8 a. m. About 1/10 lower clouds moving from easterly directions after 8:30 a. m.

Centers of low pressure were present over Minnesota and southern Illinois and a center of high pressure over Maine.

August 4.—One balloon was used; capacity, 31.1 cu. m. Wire out, 2500 m.

About 4/10 Cu. from the west at the beginning, increasing to 6/10 by the end of flight.

Pressure was relatively low over Texas and off the coast of North Carolina and centers of high pressure were over southern Virginia and New England.

August 5.—First ascension: One balloon was used; capacity, 31.1 cu. m. Wire out, 1500 m.

At the beginning there were about 8/10 Cu. from the west-northwest; a thunderstorm was observed in the west. The latter rapidly approached the station and the clouds changed to St. and Cu.-N. Rain began at 1:59 p. m. and continued throughout the remainder of the ascension.

Second ascension: Two balloons were used; capacity, 62.2 cu. m. Wire out, 3300 m.

About 9/10 A.-St. from the northwest.

At 8 a. m. barometric conditions east of the Mississippi River were comparatively flat. There was a slight depression off Long Island.

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Aug. 6.	mm.	° C.	%		m. p. s.	Meters.	mm.	° C.	%		m. p. s.
12:51 p.m.	717.6	22.6	71	e.	2.2	526	717.6	22.6	71	e.	2.2
1:18 p.m.	717.6	23.0	77	e.	2.9	3552	500.2	− 0.2	......	nw.	....
1:25 p.m.	717.6	23.6	70	e.	3.1	3300	515.7	0.1	......	nw.	....
1:49 p.m.	717.6	23.8	70	e.	4.2	2426	574.3	8.2	......	nw.	....
2:03 p.m.	717.6	24.2	71	e.	3.1	1621	632.1	13.9	......	nnw.	....
2:09 p.m.	717.6	24.2	71	e.	2.9	1272	658.4	17.0	......	nnw.	....
2:24 p.m.	717.6	24.4	70	e.	2.7	526	717.6	24.4	70	e.	2.7
Aug. 7.											
9:11 a.m.	721.0	21.2	85	nw.	2.2	526	721.0	21.2	85	nw.	2.2
9:36 a.m.	721.1	22.5	86	wnw.	1.8	2432	577.0	11.1	......	nne.	....
9:46 a.m.	721.1	23.4	78	nw.	1.8	1850	618.3	13.9	......	e.	....
9:58 a.m.	721.1	23.6	79	ne.	2.2	1459	647.5	17.5	......	se.	....
10:07 a.m.	721.1	24.0	77	n.	1.8	989	683.8	20.3	......	ne.	....
10:13 a.m.	721.1	24.2	75	n.	1.8	526	721.1	24.2	75	n.	1.8
Aug. 8.											
8:46 a.m.	721.4	22.8	79	wnw.	2.7	526	721.4	22.8	79	wnw.	2.7
9:08 a.m.	721.4	23.4	76	w.	3.0	2485	575.2	16.2	......	calm.	....
9:26 a.m.	721.4	24.2	76	w.	2.7	2007	608.4	18.3	......	calm.	....
9:35 a.m.	721.4	23.8	77	w.	2.7	1509	644.4	19.9	......	ssw.	....
9:54 a.m.	721.4	25.2	72	wnw.	2.2	1016	682.2	21.4	......	s.	....
10:02 a.m.	721.4	25.4	70	wnw.	2.2	727	705.1	24.3	......	wsw.	....
10:08 a.m.	721.4	25.4	70	wnw.	2.2	526	721.4	25.4	70	wnw.	2.2

RESULTS OF KITE FLIGHTS.

Date and hour.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
Aug. 9.											
6:48 a.m.	717.3	23.0	68	w.	7.2	526	717.3	23.0	68	w.	7.2
6:52 a.m.	717.3	23.2	68	w.	7.6	888	688.3	23.1	......	wnw.	....
7:10 a.m.	717.2	23.6	66	wnw.	6.7	1033	676.8	21.8	......	nw.	....
7:24 a.m.	717.2	23.6	68	w.	7.6	1206	663.5	21.9	......	nw.	....
7:44 a.m.	717.1	24.0	67	w.	7.6	1306	655.8	21.2	......	nw.	....
8:22 a.m.	717.0	24.9	65	wnw.	7.6	1531	639.1	19.8	......	nnw.	....
8:36 a.m.	716.9	25.0	62	wnw.	8.0	1664	629.1	18.1	......	nnw.	....
9:05 a.m.	716.9	25.4	63	wnw.	7.6	1830	617.1	17.1	......	nnw.	....
9:30 a.m.	716.8	25.8	64	wnw.	6.7	1604	633.4	18.1	......	nnw.	....
10:04 a.m.	716.8	26.8	62	wnw.	6.3	1331	653.9	20.5	......	nnw.	....
10:40 a.m.	716.8	27.5	58	wnw.	6.7	981	680.7	22.4	......	nw.	....
11:01 a.m.	716.8	28.0	55	wnw.	7.2	526	716.8	28.0	55	nw.	7.2

August 6.—Two captive balloons were used; capacity, 62.2 cu. m. Wire out, 4000 m.

Cu. from the northwest decreased from 9/10 at the beginning to 0 at the end. The balloons entered the Cu. at an altitude of about 2300 m.

Pressure was moderately high over Michigan and relatively low off the coast of Massachusetts, and over western Virginia.

August 7.—One balloon was used; capacity, 31.1 cu. m. Wire out, 2200 m.

A few Cu. from the north-northeast after 9:15 a. m.

High pressure was central over the Lake region, low pressure over the Gulf.

August 8.—One balloon was used; capacity, 31.1 cu. m.

The sky was cloudless till 9 a. m. after which a few Cu. from the southwest.

A high was central over Virginia and a low over the Gulf.

August 9.—Six kites were used; lifting surface, 38.3 sq. m. Wire out, 5800 m.; at maximum altitude, 5200 m.

No clouds were observed.

An area of relatively low pressure was central over northern Maine and Quebec; areas of high pressure were central over Tennessee and northern Minnesota.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.											
Aug. 10.	mm.	° C.	%		m. p. s.	Meters.	mm.	° C.	%		m. p. s.
7:16 a. m....	716.4	21.4	87	nw.	6.7	526	716.4	21.4	87	nw.	6.7
7:44 a. m....	716.4	21.9	86	nnw.	5.4	1326	652.7	14.6	......	nw.	....
8:19 a. m....	716.4	22.6	78	nw.	7.6	1814	616.4	15.6	......	nw.	....
8:40 a. m....	716.3	23.2	71	wnw.	4.5	2641	559.1	9.3	......	nw.	....
9:05 a. m....	716.3	23.3	64	nnw.	6.3	3322	515.0	5.1	......	nw.	....
9:28 a. m....	716.3	23.0	64	nnw.	6.3	4096	467.5	− 0.9	......	nw.	....
9:56 a. m....	716.1	24.0	71	nw.	5.8	4566	440.3	− 6.1	......	nw.	....
12:23 p. m....	716.2	26.4	45	nnw.	5.8	3821	483.0	1.3	......	wnw.	....
1:03 p. m....	716.1	27.7	39	n.	5.4	3051	530.6	5.1	......	nw.	....
1:23 p. m....	715.9	27.9	38	n.	5.4	2882	542.3	5.9	......	nw.	....
1:39 p. m....	715.6	27.4	37	n.	5.8	2540	565.0	4.1	......	nw.	....
2:00 p. m....	715.7	27.9	38	n.	5.4	1733	622.6	12.9	......	nw.	....
2:37 p. m....	715.5	28.4	32	nw.	5.6	1130	668.0	20.1	......	nw.	....
2:57 p. m....	715.1	28.0	32	nw.	5.8	526	715.1	28.0	32	nw.	5.8

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Aug. 11.											
1:35 p. m....	719.3	22.8	36	w.	3.1	526	719.3	22.8	36	w.	3.1
1:51 p. m....	719.2	23.2	31	w.	4.0	2616	563.0	9.2	......	nnw.	....
2:05 p. m....	719.2	22.8	32	nw.	2.7	2064	600.7	10.3	......	nnw.	....
2:18 p. m....	719.1	23.2	31	n.	1.8	1615	633.3	11.1	......	se.	....
2:33 p. m....	719.1	24.0	32	w.	2.7	1070	675.3	16.2	......	calm.	....
2:42 p. m....	719.1	23.6	32	w.	1.8	526	719.1	23.6	32	w.	1.8

August 10.—Four kites were used; lifting surface, 25.7 sq. m. Wire out 7175 m.; at maximum altitude, 6950 m.

Light fog and from 6/10 to 8/10 St. from the north-northwest till about 8 a. m., and from 6/10 to 1/10 Cu. from the northwest between 8:30 a. m. and 1 p. m. From 1 p. m. to the end of the flight the sky was partly covered with Ci.-St. and Cu. from the northwest. The head kite was in the clouds at intervals from 8:11 a. m. to 2:00 p. m.

A high was central over Lake Superior and one over Missouri. A low was central over the Maine coast.

August 11.—One balloon was used; capacity, 31.1 cu. m. Wire out, 2400 m.

Few Ci. and 2/10 A.-St. from the west.

An area of low pressure was central over the coast of North Carolina and an area of high pressure over Ontario.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m. Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	At different heights above sea. Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909.											
Aug. 12.	mm.	° C.	%		m. p. s.	Meters.	mm.	° C.	%		m. p. s.
7:31 a. m....	719.5	15.7	81	s.	5.4	526	719.5	15.7	81	s.	5.4
7:40 a. m....	719.5	15.6	81	s.	4.5	856	692.1	14.7	......	s.	....
8:11 a. m....	719.5	15.7	79	sse.	4.9	1043	676.8	11.7	......	sse.	....
9:05 a. m....	719.5	15.7	81	s.	4.9	1372	650.5	8.0	......	s.	....
10:20 a. m....	719.3	15.7	89	se.	4.9	1916	608.8	4.5	......	wsw.	....
11:17 a. m....	719.0	16.2	86	se.	4.9	2473	568.5	0.9	......	wsw.	....
11:55 a. m....	718.8	16.2	90	se.	4.5	2723	551.0	4.6	......	wsw.	....
12:00 m	718.8	16.3	89	se.	3.6	2846	543.2	3.5	......	wsw.	....
12:12 p. m....	718.8	16.4	90	se.	4.9	2370	575.6	5.4	......	wsw.	....
12:22 p. m....	718.6	16.7	88	se.	5.4	2197	588.1	4.1	......	wsw.	....
12:32 p. m....	718.6	16.8	85	se.	5.4	2052	598.5	4.1	......	wsw.	....
12:54 p. m....	718.5	16.8	82	se.	4.9	1749	620.9	6.1	......	s.	....
1:09 p. m....	718.5	16.8	79	se.	4.9	1125	669.2	9.6	......	sse.	....
1:25 p. m....	718.5	16.3	63	se.	4.9	820	694.0	11.2	......	sse.	....
1:34 p. m....	718.5	16.3	65	se.	4.9	526	718.5	16.3	65	se.	4.9

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Aug. 13.											
10:18 a. m....	717.1	20.0	76	ese.	3.1	526	717.1	20.0	76	ese.	3.1
10:34 a. m....	717.1	19.1	81	ese.	2.7	2255	585.4	12.3	......	nw.	....
10:52 a. m....	717.1	20.1	78	ese.	2.7	1647	629.2	14.5	......	nw.	....
11:07 a. m....	717.1	20.4	77	e.	3.1	1438	644.9	16.0	......	wnw.	....
11:19 a. m....	717.1	21.3	74	ese.	2.7	1024	676.9	17.1	......	wnw.	....
11:27 a. m....	717.1	19.8	78	ese.	2.2	526	717.1	19.8	78	ese.	2.2
Aug. 14.											
1:02 p. m....	718.5	19.0	85	se.	3.6	526	718.5	19.0	85	se.	3.6
1:20 p. m....	718.4	18.8	83	se.	4.5	2283	585.5	17.7	......	sw.	....
1:30 p. m....	718.3	19.1	83	se.	4.9	1778	620.8	19.1	......	sw.	....
1:45 p. m....	718.4	18.9	82	se.	4.0	1462	644.1	16.2	......	sw.	....
2:12 p. m....	718.3	19.0	79	se.	5.4	526	718:3	19.0	79	se.	5.4

August 12.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 6300 m.; at maximum altitude, 4000 m.

The sky was overcast with St. from the south shifting to southwest. The head kite entered the clouds at 10:08 a. m. at an altitude of 1970 m. and was seen occasionally until it was brought below the clouds at an altitude of 1125 m. at 1:09 p. m. Light rain fell at intervals from 8 to 10 a. m.

Pressure was high over the New England and Middle Atlantic States and relatively low off the South Carolina coast.

August 13.—One balloon was used; capacity, 31.1 cu. m.; Wire out, 2200 m.

About 8/10 S. Cu. from the east-southeast during the flight. (The balloon was frequently in the clouds at altitudes between 1500 m. and 1800 m.).

An area of relatively low pressure was central off the coast of North Carolina. Pressure was high off the New England coast.

August 14.—One balloon was used; capacity 31.1 cu m. Wire out, 2200 m.

About 10/10 St. from the southeast during the flight. The balloon was in the clouds at altitudes above 1000 m.

High pressure was central over Maine and low pressure over South Carolina.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909. Aug. 15.	*mm.*	*° C.*	*%*		*m. p. s.*	*Meters.*	*mm.*	*° C.*	*%*		*m. p. s.*
6:20 a. m.	717.7	15.8	100	se.	5.4	526	717.7	15.8	100	se.	5.4
6:23 a. m.	717.7	15.7	100	se.	5.4	867	689.4	13.9	......	ese.	....
6:44 a. m.	717.6	15.7	100	se.	4.9	1033	676.0	16.4	......	ese.	....
7:27 a. m.	717.6	15.8	100	se.	5.4	1442	644.0	12.4	......	s.	....
7:54 a. m.	717.6	15.8	100	se.	6.3	1078	672.2	14.7	......	s.	....
8:03 a. m.	717.6	15.9	100	se.	6.7	866	689.4	12.8	......	s.	....
8:31 a. m.	717.5	15.9	100	se.	6.7	526	717.5	15.9	100	se.	6.7

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Aug. 16.											
1:15 p. m.	708.4	22.2	86	w.	3.1	526	708.4	22.2	86	w.	3.1
1:28 p. m.	708.3	23.1	82	w.	1.8	2071	592.1	15.3	......	nnw.	....
1:50 p. m.	708.2	23.9	81	calm.	1.8	1263	650.6	19.0	......	nnw.	....
2:10 p. m.	708.0	23.9	78	wnw.	2.7	1209	654.4	19.0	......	nnw.	....
2:24 p. m.	707.8	23.8	78	wnw.	3.1	715	692.5	20.9	......	nw.	....
2:39 p. m.	707.6	24.0	77	nnw.	3.6	526	707.6	24.0	77	nnw.	3.6

RESULTS OF KITE FLIGHTS.

Aug. 17.											
8:46 a. m.	706.7	15.8	100	nnw.	5.8	526	706.7	15.8	100	nnw.	5.8
9:37 a. m.	706.9	16.4	98	nnw.	6.3	744	689.0	14.9	......	nnw.	....
9:48 a. m.	706.9	16.8	94	nnw.	6.7	864	679.4	16.4	......	nnw.	....
10:04 a. m.	707.0	17.9	89	nnw.	5.4	1206	652.7	14.3	......	nnw.	....
10:39 a. m.	707.0	18.5	83	nnw.	5.4	1696	615.8	10.4	......	nnw.	....
12:13 p. m.	707.0	19.5	77	nnw.	4.5	2345	569.2	4.5	......	nnw.	....
1:15 p. m.	706.7	21.2	73	nnw.	4.0	2779	540.0	1.3	......	nnw.	....
1:30 p. m.	706.6	20.9	75	nw.	4.0	2319	571.2	5.1	......	nw.	....
1:44 p. m.	706.6	21.4	72	nw.	3.1	1780	609.5	7.9	......	nw.	....
1:54 p. m.	706.6	21.0	76	nw.	4.0	1273	647.0	12.2	......	nw.	....
1:59 p. m.	706.6	20.7	76	nw.	4.0	864	679.4	16.3	......	nw.	....
2:07 p. m.	706.6	21.0	75	nw.	3.1	526	706.6	21.0	75	nw.	3.1

August 15.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 3300 m.; at maximum altitude, 3200 m.

Light rain and dense fog prevailed.

High pressure was central off the New England coast, low pressure over the Lakes. Pressure was relatively low over the south Atlantic coast.

August 16.—One balloon was used; capacity, 31.1 cu. m.; Wire out, 2400 m.

Dense fog preceded the ascension, lifting at 11:45 a. m. When the balloon was launched, 2/10 A.-St. from the northwest and 6/10 St.-Cu. from the west was observed. The latter decreased to a few by the end of the ascension. (The balloon was in St.-Cu. at altitudes greater than 1300 m.).

An area of relatively low pressure was central over Lake Erie, an area of moderately high pressure over New Brunswick.

August 17.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 4320 m.; at the maximum altitude, 3,250 m.

At the beginning of the flight the sky was practically overcast with low St. which partially dissipated between 9 and 9:30 a. m. Thereafter there were from 4/10 6/10 A.-Cu. and Cu. until near the close of the flight when about 5/10 St. appeared. All clouds moved from the northwest.

At 8 a. m. a low, accompanied by general precipitation, was central off the coast of New Jersey. Pressure was high over Nova Scotia.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Aug. 18.	mm.	°C.	%		m. p. s.	Meters.	mm.	°C.	%		m. p. s.
7:35 a. m....	706.3	17.1	95	wnw.	11.6	526	706.3	17.1	95	wnw.	11.6
7:42 a. m....	706.3	17.4	85	wnw.	11.6	914	674.9	15.4	......	wnw.	....
7:50 a. m....	706.3	17.4	85	wnw.	12.1	1274	646.7	12.4	......	nw.	....
8:18 a. m....	706.3	18.0	84	wnw.	9.8	2001	592.7	7.2	......	nw.	....
9:36 a. m....	706.4	19.6	72	wnw.	10.7	2277	573.7	5.6	......	nw.	....
10:16 a. m....	706.5	19.6	74	wnw.	8.0	2633	549.1	7.7	......	nw.	....
10:49 a. m....	706.6	19.5	72	wnw.	8.9	1861	603.0	6.5	......	nw.	....
11:16 a. m....	706.6	19.7	72	wnw.	7.2	1235	650.1	11.2	......	wnw.	....
11:33 a. m....	706.7	19.8	71	wnw.	8.0	872	678.8	15.5	......	wnw.	....
11:38 a. m....	706.7	19.2	74	wnw.	8.7	526	706.7	19.2	74	wnw.	8.7
Aug. 19.											
8:53 a. m....	710.2	18.8	70	nw.	7.6	526	710.2	18.8	70	nw.	7.6
9:10 a. m....	710.2	19.2	76	nw.	8.0	916	678.6	14.5	......	nnw.	....
9:44 a. m....	710.3	20.0	66	nw.	4.5	1451	637.1	11.3	......	nnw.	....
10:09 a. m....	710.3	20.6	75	nw.	3.6	1810	610.6	9.6	......	nnw.	....
10:30 a. m....	710.3	21.2	70	nw.	3.6	2286	577.4	9.0	......	nnw.	....
11:22 a. m....	710.3	24.2	68	nw.	5.6	2998	529.4	2.2	......	nnw.	....
12:42 p. m....	710.3	23.2	61	nw.	7.2	3534	495.5	− 2.0	......	nnw.	....
2:01 p. m....	710.3	22.8	60	nw.	6.3	3103	522.7	1.0	......	nnw.	....
2:19 p. m....	710.3	24.2	61	nw.	4.5	2448	566.5	6.0	......	nnw.	....
2:45 p. m....	710.0	22.8	67	nw.	7.6	1671	620.8	9.9	......	nw.	....
3:02 p. m....	710.0	23.9	65	nw.	4.5	1282	650.4	14.6	......	nw.	....
3:20 p. m....	709.8	24.0	66	nw.	4.5	526	709.8	24.0	66	nw.	4.5
Aug. 20.											
8:03 a. m....	714.1	19.6	60	wnw.	4.9	526	714.1	19.6	60	wnw.	4.9
8:48 a. m....	714.3	20.3	59	wnw.	5.4	811	691.3	22.4	......	nnw.	....
9:03 a. m....	714.4	20.6	60	wnw.	5.8	932	681.8	21.6	......	nnw.	....
9:34 a. m....	714.5	21.2	58	wnw.	5.8	1587	632.1	15.7	......	nnw.	....
9:44 a. m....	714.5	21.3	58	wnw.	6.3	1084	670.3	19.7	......	nnw.	....
10:30 a. m....	714.6	22.6	58	wnw.	5.4	672	702.8	24.6	......	nw.	....
10:44 a. m....	714.6	22.5	58	wnw.	5.4	526	714.6	22.5	58	wnw.	5.4

August 18.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 6000 m.; at maximum altitude, 4700 m.

About 5/10 St. were observed at the beginning and diminished to 2/10 by 9:15 a. m. A.-St. began to form at 9 a. m. and increased to 10/10 by the end of the flight. All clouds were moving from the west. The head kite was in St. at altitudes greater than 2000 m.; in A.-St. at 2500 m.; and in St.-Cu. at 1200 m.

Areas of relatively low pressure were central off the coast of Massachusetts, and North Carolina. An area of high pressure was central over Nevada.

August 19.—Seven kites were used; lifting surface, 44.1 sq. m. Wire out, 6600 m.; at maximum altitude, 6100 m.

At 9:35 a. m. Cu. began to form and move from the northwest. They increased to 5/10 at 1:30 p. m., after which they gradually disappeared. Low St.-Cu. moving from the northwest appeared at about 2 p. m. and increased to 9/10 by the end of the flight.

Low pressure was central over Maine and Mississippi and high pressure over Saskachewan.

August 20.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 3100 m.; at maximum altitude, 2600 m.

A few Ci. direction indeterminable, were observed during the flight. A few. St.-Cu. moving from the west from the beginning of the flight to 9 a. m., and a few A.-St. from the northwest from about 9 a. m. to the end.

Areas of relatively low pressure were central over Maine and off the west coast of Florida, an area of high pressure over Minnesota.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m. Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	At different heights above sea. Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909.											
Aug. 21.	mm.	°C.	%		m. p. s.	Meters.	mm.	°C.	%		m. p. s.
6:53 a. m.	719.3	14.0	84	n.	4.0	526	719.3	14.0	84	n.	4.0
7:07 a. m.	719.3	14.2	84	nnw.	3.6	911	687.3	12.8	......	n.	....
7:39 a. m.	719.4	14.6	82	nnw.	4.0	1267	658.7	11.0	......	n.	....
8:13 a. m.	719.7	15.2	82	nnw.	3.6	1716	624.3	7.0	......	n.	....
9:36 a. m.	720.4	16.5	76	nw.	4.9	1997	603.9	4.2	......	n.	....
10:05 a. m.	720.5	17.4	74	nw.	4.9	2427	573.4	2.1	......	n.	....
10:35 a. m.	720.6	18.0	63	nw.	5.4	2744	551.9	1.3	......	nnw.	....
11:04 a. m.	720.6	18.6	59	nw.	5.4	2002	603.9	3.4	......	nnw.	....
11:18 a. m.	720.6	18.7	61	nw.	4.9	1654	630.0	5.4	......	n.	....
11:31 a. m.	720.6	18.9	60	nnw.	4.9	1119	672.0	11.5	......	nnw.	....
11:35 a. m.	720.7	19.0	64	nnw.	4.9	884	691.1	13.6	......	nnw.	....
11:41 a. m.	720.7	19.2	68	nnw.	4.9	526	720.7	19.2	68	nnw.	4.9

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Date and hour.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
Aug. 22.											
8:15 a. m.	724.3	13.2	75	wnw.	3.1	526	724.3	13.2	75	wnw.	3.1
8:26 a. m.	724.3	13.7	74	wnw.	3.6	2104	599.9	11.9	......	n.	....
8:42 a. m.	724.4	13.9	71	wnw.	3.6	1278	662.3	10.1	......	nw.	....
8:59 a. m.	724.4	14.1	69	wnw.	3.1	1112	675.7	11.7	......	nw.	....
9:16 a. m.	724.4	14.8	62	wnw.	3.1	526	724.4	14.8	62	wnw.	3.1

RESULTS OF FREE BALLOON ASCENSIONS.

Date and hour.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
Aug. 22.											
1:39 p. m.	723.7	20.0	40	n.	0.9	526	723.7	20.0	40	n.	0.9
2:33 p. m.	723.4	21.5	35	wnw.	0.9	6759	333.6	−19.4	......	n.	....
3:20 p. m.	723.2	22.0	33	nw.	1.3	526	723.2	22.0	33	nw.	1.3

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Date and hour.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
Aug. 23.											
1:04 p. m.	722.2	24.6	54	s.	2.7	526	722.2	24.6	54	s.	2.7
1:30 p. m.	722.0	25.7	50	ese.	2.2	2629	565.8	13.0	......	w.	....
1:40 p. m.	721.9	25.6	45	s.	2.7	2010	608.1	14.2	......	w.	....
1:58 p. m.	721.7	26.3	48	e.	1.8	1403	652.5	17.0	......	sw.	....
2:17 p. m.	721.6	26.8	48	e.	1.8	976	685.6	22.0	......	s.	....
2:28 p. m.	721.6	26.4	47	se.	1.8	526	721.6	26.4	47	se.	1.8

August 21.—Six kites were used; lifting surface, 38.3 sq. m. Wire out, 4600 m.; at maximum altitude, 4100 m.

From a few to 2/10 Cu. moving from the north-northwest. The head kite was obscured by the Cu. from 10:51 to 10:54 a. m. The cloud level was about 1200 m.

A high was central over Michigan and a low off the New England coast.

August 22.—Captive balloon ascension: One balloon was used; capacity, 31.1 cu m. Wire out, 2700 m.

The sky was cloudless during both ascensions.

At 8 a. m. a well developed area of high pressure was central over Pennsylvania, and a moderate low over Lake Superior.

The captive balloon broke away while reeling in.

August 23.—One balloon was used; capacity, 31.1 cu. m. Wire out, 2500 m.

A few Cu. from the north.

Areas of relatively low pressure were central over Quebec and Gulf of Mexico; an area of high pressure over West Virginia.

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.											
Aug. 24.	*mm.*	*° C.*	*%*		*m. p. s.*	*Meters.*	*mm.*	*° C.*	*%*		*m. p. s.*
1:40 p. m....	721.6	27.2	44	w.	2.2	526	721.6	27.2	44	w.	2.2
2:07 p. m....	721.4	27.2	39	w.	1.3	2811	564.0	12.9	......	calm.	....
2:10 p. m....	721.4	27.2	38	w.	1.3	2327	586.5	15.6	......	calm.	....
2:27 p. m....	721.3	27.0	42	w.	1.8	1703	630.2	17.0	......	calm.	....
2:38 p. m....	721.2	27.8	44	w.	1.3	1095	676.0	20.8	......	ssw.	....
2:48 p. m....	721.1	28.8	44	w.	1.8	526	721.1	28.8	44	w.	1.8
RESULTS OF KITE FLIGHTS.											
Aug. 25.											
7:19 a. m....	722.1	20.2	68	w.	6.3	526	722.1	20.2	68	w.	6.3
8:20 a. m....	722.1	21.0	69	w.	5.8	581	717.5	27.5	......	nnw.	....
10:12 a. m....	722.2	23.9	60	wnw.	5.4	770	702.6	24.9	......	nw.	....
10:29 a. m....	722.2	24.0	59	wnw.	5.8	1286	662.0	21.0	......	nw.	....
10:49 a. m....	722.1	24.6	59	wnw.	5.4	813	698.9	22.9	......	nnw.	....
11:01 a. m....	722.1	24.8	57	nw.	5.4	526	722.1	24.8	57	nw.	5.4
Aug. 26.											
7:11 a. m....	718.8	22.3	65	w.	6.7	526	718.8	22.3	65	w.	6.7
7:17 a. m....	718.8	22.1	68	w.	4.9	922	686.8	21.1	......	wnw.	....
9:04 a. m....	718.8	23.1	66	w.	4.5	1326	655.5	19.1	......	nw.	....
9:56 a. m....	718.8	24.2	65	w.	4.5	1725	625.9	16.1	......	nw.	....
10:14 a. m....	718.8	24.3	66	w.	4.0	2258	588.2	14.1	......	nw.	....
11:06 a. m....	718.7	25.0	67	w.	5.4	3149	528.5	7.5	......	w.	....
11:19 a. m....	718.6	24.8	69	w.	5.4	2759	553.8	10.1	......	w.	....
11:39 a. m....	718.5	24.3	70	w.	4.5	2275	586.3	12.1	......	w.	....
11:53 a. m....	718.5	22.8	76	w.	5.4	1872	614.8	15.0	......	w.	....
12'05 p. m....	718.5	22.5	81	w.	5.4	1414	648.1	16.0	......	w.	....
12:16 p. m....	718.5	22.7	78	w.	6.7	944	684.9	20.1	......	w.	....
12:25 p. m....	718.2	23.0	76	w.	8.9	526	718.2	23.0	76	w.	8.9

August 24.—One balloon was used; capacity, 31.1 cu. m. Wire out, 2400 m.

About 1/10 Ci. from the west.

Areas of low pressure were central over eastern Texas, Cuba, and Minnesota; an area of high pressure over West Virginia.

August 25.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 2500 m.; at maximum altitude, 2000 m.

After 8:35 a. m. a few Ci.-St., whose direction was indeterminable, were present.

Areas of low pressure were central over Quebec, Cuba, and Manitoba; an area of high pressure over West Virginia.

August 26.—Six kites were used; lifting surface, 38.3 sq. m. Wire out, 5650 m.; at maximum altitude, 4000 m.

The sky was from 3/10 to 9/10 obscured by Ci.-St. and A.-Cu. from the west until 8 a. m., by A.-Cu. from the west and St.-Cu. from the west-northwest from 8 to about 10 a. m., and by St. from the west after 10 a. m. A solar halo was observed from 11:35 a. m. to 12:09 p. m. Light rain fell from 11:35 a. m. to 12:09 p. m.

Low pressure was central over Quebec. Pressure was high over eastern Tennessee.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909. Aug. 27.	*mm.*	*° C.*	%		*m. p. s.*	*Meters.*	*mm.*	*° C.*	%		*m. p. s.*
7:19 a. m....	718.8	20.6	86	nw.	4.5	526	718.8	20.6	86	nw.	4.5
7:30 a. m....	718.8	20.5	82	nnw.	5.4	824	694.5	19.3	......	nw.	....
7:45 a. m....	718.8	20.5	82	nw.	5.4	1365	652.1	17.7	......	nnw.	....
8:09 a. m....	718.8	21.0	77	nnw.	4.9	1965	607.7	13.7	......	nnw.	....
8:37 a. m....	718.8	21.5	72	nnw.	4.9	2600	563.5	10.0	......	nw.	....
9:10 a. m....	718.8	21.9	73	nnw.	4.9	3458	508.2	5.5	......	nnw.	....
10:08 a. m....	718.8	23.2	55	nnw.	5.8	3984	476.9	2.8	......	nw.	....
10:25 a. m....	718.8	23.3	52	nnw.	5.4	3468	508.2	5.9	......	nw.	....
11:08 a. m....	718.7	24.4	47	nw.	5.4	2663	559.8	9.2	......	nw.	....
11:28 a. m....	718.7	24.6	41	nw.	5.4	1792	620.6	13.5	......	nnw.	....
11:41 a. m....	718.6	24.6	42	nw.	4.0	1295	657.6	16.9	......	nnw.	....
11:52 a. m....	718.6	25.0	45	nw.	3.6	685	705.7	21.5	......	nnw.	....
11:57 a. m....	718.6	25.2	46	nw.	3.6	526	718.6	25.2	46	nw.	3.6

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Aug. 28.											
8:29 a. m....	718.1	22.2	57	ese.	4.0	526	718.1	22.2	57	ese.	4.0
8:46 a. m....	718.1	22.0	61	e.	2.7	1974	607.1	16.0	......	wnw.	....
9:11 a. m....	718.1	22.2	54	e.	2.7	1460	644.1	18.5	......	wnw.	....
9:20 a. m....	718.1	22.6	53	e.	2.2	755	690.5	22.3	......	wsw.	....
9:36 a. m....	718.1	23.4	54	e.	2.0	526	718.1	23.4	54	e.	2.0

RESULTS OF KITE FLIGHTS.

Aug. 29.											
8:09 a. m....	715.9	22.6	73	w.	8.0	526	715.9	22.6	73	w.	8.0
8:18 a. m....	715.9	22.8	72	w.	8.0	983	679.5	24.1	......	w.	....
8:27 a. m....	715.9	23.1	76	w.	8.0	1226	661.0	22.5	......	w.	....
8:42 a. m....	716.0	23.4	74	w.	8.5	1699	625.9	18.1	......	w.	....
9:05 a. m....	716.0	23.2	74	wnw.	7.6	2363	578.9	12.6	......	w.	....
9:55 a. m....	716.2	24.8	74	wnw.	5.4	3642	496.5	3.7	......	w.	....
10:23 a. m....	716.3	25.8	71	w.	6.3	2756	551.9	9.8	......	w.	....
10:45 a. m....	716.4	25.4	71	w.	6.7	1954	607.3	15.2	......	w.	....
11:00 a. m....	716.4	25.3	70	w.	8.9	1373	649.9	19.2	......	w.	....
11:33 a. m....	716.5	24.5	70	nw.	8.0	1251	659.1	17.9	......	wnw.	....
11:49 a. m....	716.5	22.8	82	nw.	8.9	526	716.5	22.8	82	nw.	8.9

August 27.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 7000 m.; at maximum altitude, 6000 m.

About 2/10 Ci. from the west at the beginning diminished to few by the end of the flight.

Areas of relatively low pressure were central over Gulf of St. Lawrence and Gulf of Mexico. An area of high pressure was over the lower Lakes.

August 28.—One balloon was used; capacity, 31.1 cu. m. Wire out, 2500 m.

About 3/10 Ci. from the west.

Moderately high pressure was central over northeastern Pennsylvania and northern Virginia. Low pressure was central over Lake Superior.

August 29.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 6000 m.; at maximum altitude, 5700 m.

From 4/10 to 1/10 Ci. from the west until 9:05 a. m. A.-Cu. and St.-Cu. from the west in amounts from 3/10 to 6/10 after 9 a. m.

Lows were central over the Gulf of St. Lawrence and southern Florida. An area of high pressure extended over the Missouri Valley.

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity:
1909. Aug. 30.	*mm.*	° *C.*	%		*m. p. s.*	*Meters.*	*mm.*	° *C.*	%		*m. p. s.*
1:58 p. m....	720.5	20.4	52	nw.	2.7	526	720.5	20.4	52	nw.	2.7
2:19 p. m....	720.5	21.5	47	wsw.	2.7	2206	591.3	12.8	......	nw.	....
2:39 p. m....	720.4	21.2	52	w.	3.1	1514	....	12.1	......	calm.	....
2:58 p. m....	720.4	21.0	50	nw.	2.7	1018	....	17.0	......	calm.	....
3:06 p. m....	720.4	21.2	52	nw.	2.7	526	720.4	21.2	52	nw.	2.7

RESULTS OF KITE FLIGHTS.

Aug. 31.											
7:15 a. m....	720.2	13.6	100	se.	3.6	526	720.2	13.6	100	se.	3.6
7:28 a. m....	720.2	13.8	96	se.	3.6	866	691.8	12.8	......	se.	....
7:47 a. m....	720.2	13.8	98	e.	4.5	1302	656.8	11.8	......	ssw.	....
8:11 a. m....	720.2	14.0	98	se.	3.6	1912	610.5	7.2	......	ssw.	....
8:38 a. m....	720.1	14.4	96	e.	4.0	2228	587.6	9.2	......	sw.	....
8:48 a. m....	720.1	14.2	100	e.	4.5	2280	583.9	11.8	......	sw.	....
9:12 a. m....	720.1	14.4	100	e.	4.0	2427	573.8	12.4	......	sw.	....
9:31 a. m....	720.0	15.0	100	se.	4.5	3362	512.9	7.8	......	wsw.	....
10:46 a. m....	719.5	17.0	88	se.	5.4	2655	558.8	11.8	......	wsw.	....
10:59 a. m....	719.4	17.6	85	se.	5.8	2434	573.8	8.9	......	wsw.	....
11:33 a. m....	719.3	18.4	79	se.	4.9	1511	640.5	14.3	......	wsw.	....
12:00 m......	719.2	18.4	79	s.	5.4	1442	645.6	11.8	......	s.	....
12:17 p. m....	719.2	18.4	81	s.	3.6	973	682.5	14.1	......	s.	....
12:24 p. m....	719.1	18.6	77	s.	3.6	526	719.1	18.6	77	s.	3.6
Sept. 1											
7:10 a. m....	715.2	17.2	82	wnw.	8.5	526	715.2	17.2	82	wnw.	8.5
7:12 a. m....	715.2	17.2	82	wnw.	8.5	988	677.7	16.4	......	nw.	....
7:25 a. m....	715.2	17.2	82	wnw.	8.0	1338	650.1	13.8	......	wnw.	....
7:35 a. m....	715.2	17.7	75	nw.	10.3	1962	603.8	11.7	......	wnw.	....
7:48 a. m....	715.2	17.8	75	nw.	9.8	2102	594.0	14.0	......	w.	....
8:12 a. m....	715.2	18.2	73	nw.	9.4	2801	546.6	9.2	......	w.	....
9:00 a. m....	715.2	18.4	73	wnw.	12.1	3282	515.6	5.2	......	w.	....
9:18 a. m....	715.2	18.8	71	wnw.	10.3	4076	467.3	− 1.7	......	w.	....
10:18 a. m....	715.3	18.8	70	nw.	9.8	3109	526.0	5.4	......	w.	....
10:48 a. m....	715.3	17.9	70	nw.	11.2	2680	554.0	8.2	......	wnw.	....
10:58 a. m....	715.3	17.8	68	wnw.	11.2	2369	575.4	10.5	......	wnw.	....
11:30 a. m....	715.3	17.8	60	wnw.	11.6	1884	609.4	10.7	......	wnw.	....
11:51 a. m....	715.3	17.8	58	wnw.	13.0	1218	659.4	12.8	......	wnw.	....
12:00 m......	715.3	18.0	51	wnw.	13.0	946	....	12.9	......	wnw.	....
12:11 p. m....	715.3	18.0	51	nw.	13.0	526	715.3	18.0	51	nw.	13.0

August 30.—One balloon was used; capacity, 31.1 cu. m. Wire out, 2000 m.

About 4/10 Cu. from the northwest.

Areas of low pressure were central over Florida and Gulf of St. Lawrence. An area of relatively high pressure was central over Lake Huron.

August 31.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 5300 m.; at maximum altitude, 5000 m.

At 7 a. m. 10/10 St. from the southeast, but by the end of the flight they had decreased to 4/10. Dense fog from 8 to 9:30 a. m., and light fog from 9:30 to 10:11 a. m. The kites were in the clouds most of the time at altitudes greater than 1000 m.

High pressure was central over Maine and low pressure over Florida and the upper Lakes.

September 1.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 6500 m.; at maximum altitude, 6000 m.

Few Ci. from the west were observed. After 8:00 a. m. Cu. from the west began to form and increased to 2/10 by 9 a. m. and then decreased to 0 by the end of the flight.

Areas of low pressure were central over Quebec and off the coast of North Carolina. Pressure was high over Wisconsin.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Sept. 2.	*mm.*	° *C.*	%		*m. p. s.*	*Meters.*	*mm.*	° *C.*	%		*m. p. s.*
7:16 a. m....	719.0	8.4	79	nw.	6.7	526	719.0	8.4	79	nw.	6.7
7:20 a. m....	719.0	8.6	81	nw.	6.7	924	685.2	6.0	......	nw.	....
7:29 a. m....	719.0	8.8	81	nw.	6.7	1328	652.0	4.0	......	nnw.	....
7:34 a. m....	718.9	8.8	81	nw.	8.9	1420	644.7	6.5	......	nnw.	....
7:44 a. m....	718.9	9.2	80	nw.	8.9	1935	605.8	10.0	......	n.	....
7:54 a. m....	718.9	9.4	74	nw.	8.9	2361	575.5	7.8	......	n.	....
8:13 a. m....	718.9	9.8	72	nw.	10.7	3097	526.1	4.1	......	n.	....
9:07 a. m....	719.0	11.6	64	nw.	10.7	3687	489.4	2.5	......	nnw.	....
10:04 a. m....	719.3	12.5	52	nw.	10.7	3120	526.1	4.0	......	nnw.	....
10:30 a. m....	719.3	13.0	51	nw.	10.7	2478	569.1	6.9	......	n.	....
10:50 a. m....	719.3	13.8	50	nw.	11.1	1937	607.7	8.1	......	n.	....
11:14 a. m....	719.2	14.4	50	nw.	10.7	1348	652.0	12.5	......	n.	....
11:22 a. m....	719.1	14.4	48	nw.	10.7	933	685.2	10.0	......	n.	....
11:37 a. m....	718.9	15.0	53	nw.	11.4	526	718.9	15.0	53	nw.	11.4

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Sept. 3.											
10:37 a. m....	719.4	19.4	47	se.	1.8	526	719.4	19.4	47	se.	1.8
10:51 a. m....	719.4	19.4	44	se.	1.8	1990	605.5	11.6	......	sw.	....
10:58 a. m....	719.4	19.4	44	se.	1.8	1787	620.3	11.5	......	wsw.	....
11:18 a. m....	719.3	20.0	46	se.	1.8	1040	677.5	15.6	......	ssw..	....
11:50 a. m....	719.2	19.2	51	se	1.8	526	719.2	19.2	51	se.	1.8

RESULTS OF KITE FLIGHTS.

Sept. 4											
9:29 a. m....	716.3	13.0	100	sse.	4.0	526	716.3	13.0	100	sse.	4.0
9:33 a. m....	716.2	13.0	100	sse.	4.5	870	687.9	17.3	......	sw.	....
9:54 a. m....	716.1	13.2	100	sse.	4.5	1364	649.1	16.8	......	sw.	....
10:30 a. m....	716.0	14.8	100	sse.	4.5	1787	617.7	15.2	......	sw.	....
10:55 a. m....	715.8	16.0	96	sse.	5.4	1913	608.5	14.3	......	w.	....
11:07 a. m....	715.8	17.0	90	sse.	5.4	2238	585.6	11.6	......	w.	....
11:40 a. m....	715.6	18.1	90	s.	5.4	3243	518.4	4.6	......	w.	....
12:12 p. m....	715.5	18.4	87	s.	4.0	2597	560.6	8.3	......	w.	....
12:39 p. m....	715.4	19.5	80	sse.	5.4	1965	604.7	13.0	......	w.	....
12:56 p. m....	715.2	19.6	81	se.	3.6	1459	641.7	15.3	......	w.	....
1:13 p. m....	715.2	21.2	78	se.	4.0	983	678.6	19.7	......	sw.	....
1:20 p. m....	715.2	21.0	79	ssw.	4.5	526	715.2	21.0	79	ssw.	4.5

September 2.—Three kites were used; lifting surface, 19.4 sq. m. Wire out, 6500 m.; at maximum altitude.

The sky was cloudless.

Pressure was high over Ohio and low over the lower St. Lawrence.

September 3.—One balloon was used; capacity, 31.1 cu. m. Wire out, 2350 m.

About 9/10 Ci.-St. and few A.-St. from the southwest. (Solar halo began 10:30 and ended 11:30 a. m.).

Areas of relatively low pressure were central over western Illinois and Quebec. An area of high pressure was central off the coast of Virginia.

September 4.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 4200 m.; at maximum altitude, 4000 m.

Light fog from the beginning of the flight until 10:59 a. m. The layer of fog was about 100 m. deep over Mount Weather. About 2/10 A.-Cu. from the west were present at 9:42 a. m. and increased to 9/10 by the end of the flight. About 4/10 St. from the south-southeast at 11:07 a. m. decreased to 0 by 11:35 a. m. The head kite was in the A.-Cu. at intervals from 11:22 a. m. to 12:07 p. m. at altitudes between 2800 and 3000 m.

Pressure was high over South Carolina and low over the Great Lakes.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m. Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	At different heights above sea. Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Sept. 5	*mm.*	° *C.*	%		*m. p. s.*	*Meters.*	*mm.*	° *C.*	%		*m. p. s.*
8:35 a. m....	714.8	19.2	74	wnw.	11.2	526	714.8	19.2	74	wnw.	11.2
8:44 a. m....	714.8	19.4	74	wnw.	11.2	1032	673.8	15.0	......	nw.	....
8.57 a. m....	714.9	19.8	71	wnw.	9.8	1415	644.2	12.6	......	nw.	....
9:11 a. m....	714.9	19.8	70	wnw.	10.7	1884	609.1	8.8	......	nw.	....
9:21 a. m....	714.9	19.8	69	wnw.	10.7	2508	564.9	7.6	......	nw.	....
9:27 a. m....	714.9	19.7	71	wnw.	12.1	2388	573.1	10.1	......	nw.	....
9:35 a. m....	714.8	19.6	73	wnw.	13.9	1982	601.7	8.0	......	nw.	....
10:07 a. m....	714.8	19.7	72	wnw.	13.9	1316	651.6	13.1	......	nw.	....
10:22 a. m....	714.9	20.0	72	wnw.	12.1	943	681.0	15.2	......	nw.	....
10:33 a. m....	715.0	19.8	74	nw.	12.1	526	715.0	19.8	74	nw.	12.1

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Date and hour.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
Sept. 6.											
10:30 a. m....	721.4	14.8	51	ese.	2.2	526	721.4	14.8	51	ese.	2.2
11:00 a. m....	721.3	15.5	53	e.	2.2	2101	597.6	9.9	......	wsw.	....
11:17 a. m....	721.3	15.5	53	se.	2.7	1543	639.0	11.1	......	sse.	....
11:30 a. m....	721.2	15.7	51	se.	1.8	1028	679.5	10.1	......	wsw.	....
11:43 a. m....	721.2	15.6	54	se.	3.1	526	721.2	15.6	54	se.	3.1
Sept. 7.											
3:37 p. m....	718.8	23.2	39	calm.	1.8	526	718.8	23.2	39	calm.	1.8
3:57 p. m....	718.8	22.2	47	n.	4.0	2090	598.7	13.1	......	n.	....
4:10 p. m....	718.8	22.6	50	n.	3.1	1282	658.5	15.6	......	n.	....
4:23 p. m....	718.8	22.2	45	n.	2.2	954	684.2	19.4	......	n.	....
4:29 p. m....	718.8	24.1	43	n.	2.2	526	718.8	24.1	43	n.	2.2

September 5.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 3000 m.; at maximum altitude.

Cu. and St.-Cu., from the northwest, increased from few at the beginning to 7/10 at 9/15 a. m. About 8/10 St.-Cu. were observed at 9:20, 2/10 at 9:45, and 7/10 at 10:30 a. m. The head kite was in the clouds at intervals from 8:50 a. m., altitude, 1400 m., until 9:38 a. m.

Low pressure was central over the St. Lawrence Valley. High pressure, central over Iowa, covered the Mississippi Valley and the Gulf States.

September 6.—One balloon was used; capacity, 31.1 cu. m. Wire out, 2250 m.

About 5/10 Ci. and few A.-St. from the west.

An area of low pressure was central over Lake Superior and an area of relatively high pressure over West Virginia.

September 7.—One balloon was used; capacity, 31.1 cu. m. Wire out 2000 m.

A few Cu. were present on the southeast horizon.

High pressure was central over the upper Lakes and low pressure over the lower St. Lawrence.

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909. Sept. 8.	mm.	°C.	%		m. p. s.	Meters.	mm.	°C.	%		m. p. s.
10:13 a. m....	722.4	19.6	63	ese.	1.8	526	722.4	19.6	63	ese.	1.8
10:30 a. m....	722.4	19.8	67	se.	1.8	2025	606.7	11.2	......	e.	....
10:48 a. m....	722.3	20.3	56	se.	2.2	1355	655.6	14.6	......	s.	....
10:58 a. m....	722.3	20.4	58	se.	2.2	865	694.4	17.3	......	s.	....
11:08 a. m....	722.3	20.6	55	se.	2.2	526	722.3	20.6	55	se.	2.2

RESULTS OF KITE FLIGHTS.

Sept. 9.											
1:14 p. m....	719.9	20.8	80	se.	2.9	526	719.9	20.8	80	se.	2.9
2:40 p. m....	719.2	20.2	83	se.	4.0	877	690.4	15.8	......	s.	....
2:54 p. m....	719.1	20.2	79	se.	4.0	1153	668.4	14.8	......	e.	....
3:37 p. m....	718.9	20.5	79	se.	3.6	1510	640.6	13.0	......	s.	....
4:13 p. m....	718.7	20.4	79	se.	4.0	2512	568.7	9.1	......	sw.	....
4:30 p. m....	718.6	20.3	80	se.	4.5	1755	622.1	11.5	......	s.	....
4:39 p. m....	718.6	20.4	81	se.	4.9	1267	659.1	14.5	......	e.	....
4:50 p. m....	718.5	20.2	81	se.	3.6	824	694.1	16.5	......	e.	....
4:54 p. m....	718.5	20.2	81	se.	3.6	526	718.5	20.2	81	e.	3.6
Sept. 10.											
10:30 a. m....	714.0	18.6	100	wsw.	8.9	526	714.0	18.6	100	wsw.	8.9
10:44 a. m....	714.0	18.8	98	wsw.	5.8	941	680.3	17.0	......	w.	....
11:02 a. m....	714.0	19.6	96	w.	6.3	1466	639.8	14.9	......	nw.	....
11:27 a. m....	714.0	20.1	96	w.	5.8	1972	602.8	13.0	......	nw.	....
11:48 a. m....	713.9	21.0	89	w.	6.3	2534	564.1	10.9	......	wnw.	....
1:00 p. m....	713.8	22.0	85	w.	4.5	3018	532.3	8.0	......	w.	....
1:53 p. m....	713.6	22.4	84	nw.	2.7	3476	503.2	4.5	......	w.	....
2:38 p. m....	713.4	21.9	86	nw.	2.7	3140	523.8	5.9	......	wnw.	....
3:02 p. m....	713.3	22.6	81	wnw.	2.7	2807	545.4	7.6	......	wnw.	....
3:14 p. m....	713.3	23.2	79	wnw.	2.7	2298	579.8	10.4	......	wnw.	....
3:24 p. m....	713.4	23.6	78	w.	2.2	2140	591.0	11.0	......	wnw.	....
3:40 p. m....	713.4	23.2	79	wsw.	1.8	1391	645.3	15.6	......	w.	....
3:53 p. m....	713.5	23.7	81	s.	2.7	526	713.5	23.7	81	s.	2.7

September 8.—One balloon was used; capacity, 31.1 cu. m. Wire out, 1900 m.

The sky was cloudless.

An area of relatively low pressure was central over Cuba. Centers of high pressure were central over West Virginia and New England.

September 9.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 4000 m.; at maximum altitude, 3,000.

Cu. and St.-Cu. from the southeast nearly covered the sky until 4:15 p. m. About 4/10 Cu. and St.-Cu. from the southeast at 4:30 p. m.; and 9/10 Cu. from the south, at 4:45 p. m. The head kite was in the clouds and occasionally visible through rifts from 1:32 to 4:39 p. m.

Pressure was high over Quebec and was relatively low over Missouri.

September 10.—Six kites were used; lifting surface, 38.3 sq. m. Wire out, 5400 m. at maximum altitude.

About 2/10 A.-St. and 8/10 St. from the west at the beginning of the flight. The A.-St. disappeared by noon. After 12:30 p. m. a few St.-Cu. from the northwest The St. diminished to few and the St.-Cu. increased to 4/10 by the end of the flight Rain fell at intervals from the beginning to 10:35 a. m. and from 2:07 to 2:20 p. m. (The head kite was in the clouds at intervals from 12:35 p. m. to 3:30 p. m.).

Pressure was moderately high over the Gulf States and relatively low over the Ohio Valley.

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909. Spet. 11.	mm.	° C.	%		m. p. s.	Meters.	mm.	° C.	%		m. p. s.
1:37 p. m....	719.1	23.1	79	nw.	3.1	526	719.1	32.1	79	nw.	3.1
1:55 p. m....	719.0	23.2	72	n.	2.7	1901	612.6	12.4	......	n.	....
2:18 p. m....	719.0	22.4	74	ne.	3.6	1523	640.4	14.4	......	n.	....
2:45 p. m....	719.0	23.4	70	e.	4.0	1068	575.6	18.6	......	ne.	....
2:56 p. m....	719.0	23.2	67	e.	4.0	526	719.0	23.2	67	ne.	4.0

RESULTS OF KITE FLIGHTS.

Date and hour.	Air pres.	Air temp.	Rel. hum.	Dir.	Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Dir.	Velocity.
Sept. 12.											
8:46 a. m....	722.8	15.6	100	se.	3.1	526	722.8	15.6	100	se.	3.1
9:09 a. m....	722.9	15.8	100	se.	3.1	824	698.1	16.6	......	sse.	....
10:33 a. m....	722.9	16.3	100	se.	3.6	1082	677.3	16.9	......	s.	....
10:49 a. m....	722.9	16.4	100	se.	4.0	837	697.1	17.0	......	sse.	....
10:53 a. m....	722.9	16.5	100	se.	3.6	526	722.9	16.5	100	se.	3.6
Sept. 13.											
2:24 p. m....	721.8	21.8	64	sse.	4.0	526	721.8	21.8	64	sse.	4.0
2:43 p. m....	721.7	20.8	73	ese.	4.0	818	697.7	17.3	......	ese.	....
4:03 p. m....	721.5	20.8	70	se.	4.0	955	686.5	18.6	......	sse.	....
4:10 p. m....	721.5	20.6	70	se.	4.0	839	695.8	17.6	......	sse.	....
4:17 p. m....	721.5	20.6	71	sse.	4.0	526	721.5	20.6	71	sse.	4.0

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Date and hour.	Air pres.	Air temp.	Rel. hum.	Dir.	Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Dir.	Velocity.
Sept. 14.											
10:58 a. m....	722.5	20.8	85	sse.	1.8	526	722.5	20.8	85	sse.	1.8
11:08 a. m....	722.5	21.2	83	sse.	2.7	2076	603.0	14.2	......	e.	....
11:26 a. m....	722.5	20.6	81	sse.	3.1	1497	645.6	16.9	......	e.	....
11:46 a. m....	722.4	21.2	82	se.	2.7	1349	656.7	18.5	......	ene.	....
11:58 a. m....	722.4	21.2	82	se.	3.6	854	696.5	20.3	......	se.	....
12:01 p. m....	722.4	21.3	81	se.	3.6	648	712.2	19.2	......	se.	....
12:13 p. m....	722.4	21.8	78	se.	3.6	526	722.4	21.8	78	se.	3.6

September 11.—One balloon was used; capacity, 31.1 cu. m. Wire out, 2400 m.

From 4/10 to 1/10 Cu. from the north. The balloon entered the clouds during the ascent at an altitude of 1200 m. and appeared below the clouds during the descent at an altitude 1500 m.

Pressure was high over the upper Lakes and relatively low off the southern New England coast and over the south Atlantic coast.

September 12.—Three kites were used; lifting surface, 19.4 sq. m. Wire out, 2500 m.; at the maximum altitude, 1000 m.

At 8 a. m. a trough of low pressure extended from Manitoba southward to Texas, and a well developed high was central over Maine.

September 13.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 2500 m.; at maximum altitude, 1000 m.

Few St. from the southeeast.

A trough of low pressure extended from Manitoba to Texas. An extensive area of high pressure was central off the New England coast.

September 14.—One balloon was used; capacity, 31.1 cu. m.

The sky was cloudless.

A high was central over Maine and a trough of low pressure extended from Lake Superior to Texas.

RESULTS OF KITE FLIGHTS.

Date and hour.	Od Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Sept. 15.	*mm.*	*° C.*	%		*m. p. s.*	*Meters.*	*mm.*	*° C.*	%		*m. p. s.*
7:10 a. m....	721.8	19.8	86	s.	4.0	526	721.8	19.8	86	s.	4.0
7:23 a. m....	721.8	18.0	88	s.	4.0	936	688.3	18.7	......	s.	....
7:51 a. m....	721.8	18.3	97	s.	3.1	1053	679.0	19.5	......	s.	....
8:37 a. m....	721.8	20.0	91	s.	4.0	2368	582.3	13.5	......	ssw.	....
9:38 a. m....	721.8	20.0	91	s.	3.6	2652	562.9	13.2	......	ssw.	....
11:03 a. m....	721.8	20.3	91	s.	3.6	1669	631.5	13.5	......	ssw.	....
11:50 a. m....	721.6	22.0	87	se.	3.6	2758	555.4	11.7	......	s.	....
11:57 a. m....	721.6	22.2	84	se.	3.6	2673	561.0	12.4	......	s.	....
12:08 p. m....	721.5	22.0	84	se.	3.6	2059	603.3	11.6	......	ssw.	....
12:12 p. m....	721.5	21.6	87	se.	3.6	1645	633.4	15.1	......	ssw.	....
12:26 p. m	721.4	21.4	88	se.	3.6	526	721.4	21.4	88	se.	3.6
Sept. 16.											
1:38 p. m....	717.5	21.4	91	nne.	1.3	526	717.5	21.4	91	nne.	1.3
1:57 p. m....	717.4	20.6	96	nne.	2.2	2336	580.6	13.0	......	wnw.	....
2:07 p. m....	717.4	20.6	100	ne.	2.7	1748	622.1	14.1	......	nw.	....
2:19 p. m....	717.4	20.4	96	se.	2.7	1328	653.5	15.8	......	n.	....
2:29 p. m....	717.4	20.2	98	ese.	2.7	998	679.2	16.9	......	n.	....
2:37 p. m....	717.4	19.8	100	se.	2.7	526	717.4	19.8	100	se.	2.7

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Sept. 17.											
2:04 p. m....	718.1	21.8	62	nw.	2.7	526	718.1	21.8	62	nw.	2.7
2:14 p. m....	718.1	21.8	64	nnw.	2.7	2039	601.5	10.9	......	w.	....
2:35 p. m....	718.0	21.7	61	nnw.	2.7	1485	642.1	14.5	......	w.	....
2:58 p. m....	718.0	22.0	62	nnw.	2.7	1315	655.1	15.8	......	nw.	....
3:11 p. m....	718.0	22.2	60	n.	2.7	1055	675.5	17.6	......	n.	....
3:20 p. m....	718.0	22.4	57	nnw.	1.8	526	718.0	22.4	57	nnw.	1.8

September 15.—Six kites were used; lifting surface, 38.3 sq. m. Wire out, 5000 m.; at maximum altitude, 3800 m.

Light fog from 7:20 to 8:10 a. m. and from 9:35 to 11:00 a. m. A few Ci., direction indeterminable, from 7:00 to 8:30 a. m. A few St. from the south and later from the southeast were present from 8:30 a. m. to the end of the flight. St.-Cu. from the southeast appeared at 11:00 a. m. and had increased to 8/10 by noon.

Areas of moderately low pressure were central over Ontario and Cuba. An area of high pressure was central over Nova Scotia.

September 16.—One balloon was used; capacity 31.1 cu. m. Wire out, 2100 m.

Light fog prevailed until 2:47 p. m. and dense fog thereafter.

Pressure was high over the Mississippi Valley and the Rocky Mountains and low over the lower St. Lawrence.

September 17.—One balloon was used; capacity, 31.1 cu. m. Wire out, 2500 m.

About 2/10 Cu. from the west at the beginning, diminished to few by the end of the ascension.

Areas of low pressure were central over Cuba and the lower St. Lawrence. An area of high pressure was central over Lake Superior.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.											
Sept. 18.	mm.	° C.	%		m. p. s.	Meters.	mm.	° C.	%		m. p. s.
7:50 a. m.	721.8	16.8	59	e.	4.0	526	721.8	16.8	59	e.	4.0
8:02 a. m.	721.8	17.0	58	e.	6.7	849	695.1	16.2	......	e.	....
8:18 a. m.	721.9	17.5	58	e	5.4	1059	678.3	16.0	......	e.	....
9:53 a. m.	722.2	19.0	55	ene.	5.4	1512	643.4	13.3	......	ene.	....
10:05 a. m.	722.2	19.1	54	e.	4.0	1038	680.2	15.0	......	ne.	....
10:13 a. m.	722.2	19.0	51	e.	4.5	696	708.1	16.2	......	ne.	....
10:18 a. m.	722.2	19.2	55	e.	4.5	526	722.2	19.2	55	e.	4.5
Sept. 19.											
7:34 a. m.	725.8	12.6	100	ese.	5.8	526	725.8	12.6	100	ese.	5.8
7:44 a. m.	725.8	12.6	100	ese.	5.8	898	694.3	11.9	......	ese.	....
8:05 a. m.	725.8	12.2	99	ese.	5.8	1011	685.1	12.8	......	se.	....
10:08 a. m.	725.8	14.5	84	ese.	4.9	1127	675.8	12.0	......	ese.	....
10:59 a. m.	725.8	15.6	80	ese.	7.2	900	694.3	13.6	......	ese.	....
11:42 a. m.	725.8	15.8	76	se.	4.5	790	703.4	12.0	......	ese.	....
11:51 a. m.	725.8	15.6	76	ese.	4.0	526	725.8	15.6	76	ese.	5.8

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Sept. 20.											
1:06 p. m.	724.1	16.2	65	se.	3.1	526	724.1	16.2	65	se.	3.1
1:34 p. m.	723.9	17.7	62	se.	3.6	1415	651.4	8.9	......	s.	....
1:58 p. m.	723.7	17.1	62	se.	3.6	1155	671.8	10.9	......	sse.	....
2:26 p. m.	723.5	17.8	65	se.	3.6	860	695.7	14.0	......	se.	....
2:44 p. m.	723.3	17.7	64	se.	4.0	526	723.3	17.7	64	se.	4.0

September 18.—Four kites were used; lifting surface, 25.7 sq. m. Wire out., 2500 m.; at maximum altitude, 1800 m.

Few A.-St. on the southern horizon.

High pressure, central over Ontario, covered the eastern United States. Pressure was low over the eastern Gulf.

September 19.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 3200 m.; at maximum altitude, 3100 m.

Fog, dense at the beginning, lightened at 7:58, and disappeared by 10 a. m. Low St. from the east-southeast, covered the sky until 9 a. m. After 9 a. m. the sky was covered with St.-Cu., from the northwest until 10:15 a. m., and from the north-northwest thereafter. A few low Cu. formed a line over the valleys after 8:15 a. m. The kites were visible at intervals after 8:20, and continuously after 9 a. m.

High pressure ,central over New England, covered the eastern United States. Pressure was low over the eastern Gulf.

September 20.—One balloon was used; capacity, 31.1 cu. m. Wire out, 2400 m.

Few Ci., direction indeterminable, and 2/10 St. Cu. from the south were observed at the beginning. The St.-Cu. increased to 4/10 by the end of the ascension.

An area of low pressure was central off the coast of Lousiana. An extensive area of high pressure was central over Maine.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Sept. 21.	mm.	° C.	%		m. p. s.	Meters.	mm.	° C.	%		m. p. s.
8:30 a. m.	721.7	14.2	100	se.	6.3	526	721.7	14.2	100	se.	6.3
8:40 a. m.	721.7	14.2	100	se.	6.7	814	697.4	12.2	......	se.	....
8:50 a. m.	721.7	14.3	100	se.	6.3	1019	680.6	11.3	......	se.	....
9:18 a. m.	721.7	14.3	100	se.	6.7	1155	669.7	14.2	......	se.	....
11:36 a. m.	721.5	15.9	89	se.	5.8	1557	638.3	10.0	......	sse.	....
11:50 a. m.	721.5	16.0	90	se.	4.5	1929	610.5	9.1	......	s.	....
12:00 m.	721.5	15.8	87	se.	4.0	1754	623.5	9.1	......	sse.	....
12:10 p. m.	721.5	15.8	89	se.	4.5	1226	664.1	13.2	......	sse.	....
12:14 p. m.	721.5	16.0	90	se.	4.9	950	686.2	12.2	......	sse.	....
12:20 p. m.	721.4	16.0	90	se.	4.9	812	697.4	12.4	......	sse.	....
12:22 p. m.	721.4	15.9	86	se.	4.9	526	721.4	15.9	86	se.	4.9
Sept. 22.											
11:10 a. m.	718.0	18.3	78	se.	5.4	526	718.0	18.3	87	se.	5.1
11:17 a. m.	718.0	18.7	86	se.	5.8	907	686.8	16.1	......	sse.	....
11:29 a. m.	718.0	18.6	87	sse.	5.4	1001	679.3	19.2	......	s.	....
11:39 a. m.	717.9	18.4	87	sse.	5.4	1355	651.8	16.9	......	sw.	....
12:07 p. m.	717.9	19.0	85	se.	4.5	1479	642.5	19.4	......	wsw.	....
12:36 p. m.	717.7	19.4	83	se.	4.5	2063	600.0	15.3	......	wsw.	....
1:10 p. m.	717.5	20.6	76	se.	3.6	2339	580.7	13.5	......	wsw.	....
1:26 p. m.	717.4	20.7	76	se.	5.4	2145	593.8	13.4	......	wsw.	....
2:18 p. m.	717.2	20.8	78	s.	4.5	2277	584.5	12.9	......	wsw.	....
2:42 p. m.	717.0	21.5	76	se.	3.6	1903	611.0	15.4	......	w.	....
2:53 p. m.	716.9	22.4	73	se.	3.6	1474	642.5	17.3	......	wsw.	....
2:59 p. m.	716.9	22.0	73	se.	3.6	1229	661.0	17.5	......	wsw.	....
3:09 p. m.	716.9	21.6	76	sse.	4.0	782	696.1	19.9	......	s.	....
3:16 p. m.	716.9	21.4	75	sse.	4.0	526	716.9	21.4	75	sse.	4.0

September 21.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 4200 m.; at maximum altitude, 2200 m.

Dense fog from the beginning of the flight until 8:46 a. m. and light fog thereafter until 9:30 a. m. During the remainder of the flight 10/10 St. from the southeast at an altitude of 800 m.

High pressure was central over the New England coast, and an energetic low over Arkansas.

September 22.—Seven kites were used; lifting surface, 44.6 sq. m. Wire out, 5200 m.; at maximum altitude, 4200 m.

About 3/10 Ci.-St. and 2/10 A.-Cu. from the southwest, and 2/10 St. from the southeast at the beginning. The St. moved from the south after 1 p. m. and diminished to 0 by the end of the flight.

A trough of low pressure extended from the upper Lakes to Texas, and an area of moderately low pressure was central off the southern coast of Florida. An area of high pressure was central over Maine.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909. Sept. 23.	mm.	° C.	%		m. p. s.	Meters.	mm.	° C.	%		m. p. s.
1:03 p. m....	715.8	22.2	81	s.	4.5	526	715.8	22.2	81	s.	4.5
1:16 p. m....	715.7	22.2	82	s.	4.5	847	689.7	18.4	......	s.	....
1:45 p. m....	715.4	23.0	79	s.	3.6	1315	652.9	15.4	......	s.	....
3:21 p. m....	714.7	24.2	77	e.	4.5	1998	602.9	15.6	......	ssw.	....
4:21 p. m....	714.7	23.2	78	s.	3.6	3460	505.2	4.3	......	ssw.	....
5:06 p. m....	714.7	22.8	82	s.	4.5	2481	568.0	7.9	......	ssw.	....
5:20 p. m....	714.8	22.7	92	wnw.	8.9	2123	593.0	10.6	......	wsw.	....
5:27 p. m....	714.8	22.7	100	wnw.	13.5	1986	602.9	12.4	......	wsw.	....
6:00 p. m....	714.9	19.0	90	sw.	5.4	526	714.9	19.0	.. 90	sw.	5.4
Sept. 24.											
10:28 a. m....	718.2	13.2	71	nw.	5.4	526	718.2	13.2	71	nw.	5.4
10:35 a. m....	718.2	13.0	71	nw.	5.4	880	688.5	9.6	......	n.	....
10:40 a. m....	718.2	13.4	73	nw.	4.9	949	682.8	10.4	......	n.	....
10:46 a. m....	718.2	14.1	67	nw.	4.9	1115	669.4	9.7	......	n.	....
10:51 a. m....	718.2	14.3	68	nw.	5.4	1186	663.7	10.1	......	n.	....
11:18 a. m....	718.2	15.2	64	nw.	4.9	1523	637.4	8.4	......	nnw.	....
12:45 p. m....	718.2	15.8	51	nw.	4.5	2011	600.6	3.4	......	nnw.	....
1:10 p. m....	718.1	16.2	46	nw.	4.5	2206	586.4	4.1	......	nw.	....
1:28 p. m....	718.1	16.8	48	nw.	3.6	3679	488.1	− 4.6	......	w.	....
1:48 p. m....	718.0	17.2	45	nw.	3.6	3145	521.1	− 1.4	......	w.	....
2:18 p. m....	718.0	17.0	43	nw.	3.6	2635	555.2	2.4	......	wnw.	....
2:31 p. m....	718.1	17.2	40	nw.	4.0	2105	592.9	1.4	......	n.	....
2:45 p. m....	718.1	17.2	37	nw.	2.7	1545	635.5	3.0	......	n.	....
2:51 p. m....	718.1	17.2	37	nnw.	3.1	1140	667.5	7.4	......	n.	....
3:00 p. m....	718.1	17.2	39	nnw.	3.1	766	698.1	12.6	......	n.	....
3:09 p. m....	718.1	17.2	39	nw.	3.1	526	718.1	17.2	39	nw.	3.1
Sept. 25.											
6:52 a. m....	720.9	8.1	71	n.	4.5	526	720.9	8.1	71	n.	4.5
7:05 a. m....	720.9	8.4	78	n.	4.5	992	681.3	8.5	......	ne.	....
7:16 a. m....	721.0	8.6	80	n.	4.5	1381	650.0	6.0	......	ne.	....
7:30 a. m....	721.2	8.8	73	n.	4.0	1807	616.8	2.5	......	ne.	....
8:56 a. m....	721.6	11.6	62	nnw.	5.4	2382	575.3	2.0	......	n.	....
11:02 a. m....	721.9	15.0	62	wnw.	3.1	3034	531.5	1.2	......	n.	....
11:24 a. m....	721.9	14.6	59	nw.	3.6	2590	561.5	0.9	......	ne.	....
11:29 a. m....	721.9	14.6	59	nw.	4.5	2188	590.2	0.5	......	ne.	....
11:42 a. m....	721.9	15.0	55	wnw.	4.0	1806	618.6	2.5	......	nw.	....
11:54 a. m....	721.9	15.9	54	wnw.	4.0	1124	672.2	7.8	......	nw.	....
11:58 a. m....	721.9	15.7	58	wnw.	4.0	787	699.9	11.0	......	n.	....
12:05 p. m....	721.9	16.0	54	wnw.	4.0	526	721.9	16.0	54	wnw.	4.0

September 23.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 5000 m.; at maximum altitude, 4500 m.

At the beginning of the flight the sky was 9/10 covered with A.-St. from the south at an altitude of about 1300 m. These decreased to 2/10 by 3 p. m. After 4 p. m. A.-St. from the southwest at an altitude of about 2000 m appeared and soon covered the sky. About 5/10 Cu.-N. were observed at about 5:15 p. m. moving from the southwest and preceding a thunderstorm that shortly passed over the station. Rain fell from 5:24 to 7:30 p. m.

A trough of low pressure extended from Ontario to Alabama. A high, central over Colorado, covered the entire western part of the United States.

September 24.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 6,000 m.; at maximum altitude, 5000 m.

Few Ci. and 4/10 St.-Cu. from the west at the beginning. The St.-Cu. diminished to few by the end of the flight. (Head kite was in St.-Cu. from 1:28 to 1:33 p. m.).

Areas of low pressure were central over Quebec and southren Florida. An area of high pressure was central over Kansas.

September 25.—Seven kites were used; lifting surface, 44.6 sq. m. Wire out, 8000 m.; at maximum altitude, 5000 m.

At the beginning of the flight the sky was cloudless. A few Cu. appeared on the southwest horizon at 10:22 a. m.

High pressure, central over Lake Superior, covered the United States east of the Rocky Mountains. Pressure was low over Cuba.

RESULTS GF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Sept. 26.	*mm.*	° *C.*	%		*m. p. s.*	*Meters.*	*mm.*	° *C.*	%		*m. p. s.*
7:03 a. m...	720.7	7.9	87	nw.	4.5	526	720.7	7.9	87	nw.	4.5
7:30 a. m....	720.8	8.9	84	nw.	4.9	776	699.5	11.8	......	nne.	....
8:04 a. m....	720.8	9.4	81	nw.	4.9	1461	644.1	6.7	......	ne.	....
8:42 a. m....	720.8	10.0	81	nnw.	5.8	1944	607.1	2.6	......	nne.	....
10:00 a. m....	720.8	11.9	77	nw.	5.4	2378	574.9	− 0.9	......	nne.	....
10:20 a. m....	720.7	12.4	75	nw.	5.4	2681	553.6	1.8	......	n.	....
10:38 a. m....	720.5	12.9	73	nw.	5.4	2377	574.9	− 1.1	......	ne.	....
10:49 a. m....	720.5	13.8	72	nw.	4.5	1892	610.8	2.3	......	ne.	....
11:03 a. m....	720.4	13.8	72	nw.	4.5	1506	640.4	5.9	......	nne.	....
11:15 a. m....	720.3	14.0	66	nw.	4.5	1086	673.7	9.3	......	nne.	....
11:21 a. m....	720.3	13.8	70	nnw.	4.5	526	720.3	13.8	70	nnw.	4.5
Sept. 27.											
7:14 a. m....	717.5	5.8	95	nw.	8.5	526	717.5	5.8	95	nw.	8.5
7:20 a. m....	717.5	5.8	92	nw.	8.5	813	692.8	4.3	......	nnw.	....
7:48 a. m....	717.4	6.3	92	nw.	8.5	1237	657.7	6.6	......	n.	....
8:02 a. m....	717.3	6.7	92	nw.	8.5	1684	622.6	3.7	......	nne.	....
8:26 a. m....	717.3	7.2	90	nw.	13.0	2347	573.7	0.3	......	nne.	....
10:30 a. m....	717.0	10.5	72	nw.	11.2	2678	550.5	− 0.4	......	nw.	....
12:23 p. m....	716.9	12.6	61	nw.	9.8	2438	567.4	− 0.4	......	n.	....
12:45 p. m....	716.8	13.0	55	nw.	9.8	2016	597.9	1.8	......	n.	....
1:12 p. m....	716.7	13.0	55	nw.	8.9	1760	617.1	3.6	......	n.	....
1:30 p. m....	716.6	13.4	54	nw.	9.4	1639	626.3	2.1	......	n.	....
1:50 p. m....	716.6	13.7	53	nw.	8.9	1284	654.1	5.1	......	nnw.	....
2:05 p. m....	716.5	14.0	53	nw.	8.9	1009	676.3	7.8	......	nnw.	....
2:24 p. m....	716.4	13.4	54	nnw.	8.9	526	716.4	13.4	54	nnw.	8.9
Sept. 28.											
7:07 a. m....	716.0	5.3	86	nw.	5.8	526	716.0	5.3	86	nw.	5.8
7:21 a. m....	716.1	5.5	91	nw.	5.4	1052	671.5	4.7	......	nw.	....
7:43 a. m....	716.2	6.0	88	nw.	6.3	1633	625.3	2.6	......	nnw.	....
7:50 a. m....	716.3	6.2	87	nw.	6.3	1731	617.9	0.8	......	nnw.	....
8:03 a. m....	716.3	6.6	84	nw.	7.2	2164	585.8	5.6	......	nw.	....
9:16 a. m....	716.5	9.2	74	nw.	8.5	2527	560.8	2.7	......	nw.	....
10:25 a. m....	716.4	10.1	77	nw.	9.8	2943	532.7	0.2	......	wnw.	....
11:03 a. m....	716.3	12.0	58	nw.	10.3	3902	472.2	− 4.9	......	w.	....
11:16 a. m....	716.2	12.0	61	nw.	8.9	4550	434.8	− 7.4	......	w.	....
12:08 p. m....	716.0	8.5	53	nw.	8.5	526	716.0	13.2	53	nw.	8.5

September 26.—Six kites were used; lifting surface, 38.3 sq. m. Wire out, 4500 m.; at maximum altitude, 3800 m.

About 2/10 Ci.-St., from the west-southwest.

High pressure, central over Lake Superior, covered the United States east of the Rocky Mountains, except Florida. Low pressure was central over southern Florida.

September 27.—Seven kites were used; lifting surface, 44.1 sq. m. Wire out, 7500 m.; at maximum altitude, 7000 m.

About 6/10 Ci.-St. and a few A.-St. from the southwest at the beginning of the flight. The Ci.-St. decreased to few by 8:30 a. m. and increased to 8/10 by the end of the flight. The A.-St. disappeared by 2 p. m. After 8 a. m. a few St. moving from the northwest appeared. They increased to 6/10 by 8:30 a. m. and diminished to few by the end. A solar halo in two concentric rings, radii 22° and 45°, respectively, was observed from 9 a. m. to the end of the flight.

An area of low pressure was central off the southeastern coast of Florida. Areas of high pressure were central over Wisconsin and the Gulf of St. Lawrence.

September 28.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 7500 m.; at maximum altitude, 6700 m.

Few Cu. from the northwest.

An extensive area of high pressure was central over Oklahoma. Low pressure was central over Rhode Island.

RESULTS OF KITE FLIGHTS.

Date and hour.	At Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.											
Sept. 29.	mm.	° C.	%		m. p. s.	Meters.	mm.	° C.	%		m. p. s.
10:50 a. m....	716.6	16.6	35	s.	4.9	526	716.6	16.6	35	s.	4.9
10:59 a. m....	716.5	16.0	32	s.	4.9	885	686.8	13.0	......	s.	....
11:10 a. m....	716.5	16.6	39	s.	4.9	1052	673.4	12.9	......	ssw.	....
11:24 a. m....	716.4	16.8	39	s.	5.4	1414	645.2	12.5	......	sw.	....
11:32 a. m....	716.4	17.2	36	s.	7.2	1867	611.1	8.7	......	wsw.	....
11:50 a. m....	716.3	17.6	40	s.	8.0	2512	565.1	5.0	......	w.	....
12:04 p. m....	716.2	17.8	39	s.	6.7	3166	521.3	0.6	......	w.	....
12:58 p. m....	715.3	18.6	39	s.	5.4	4076	465.0	− 4.3	......	wsw.	....
2:18 p. m....	714.6	19.3	43	s.	5.4	3491	499.9	− 1.7	......	wsw.	....
3:02 p. m....	714.0	19.8	43	s.	4.5	3083	525.1	1.7	......	wsw.	....
3:32 p. m....	713.9	19.7	45	s.	5.8	2608	557.3	5.1	......	wsw.	....
4:08 p. m....	713.8	19.6	46	s.	5.8	2132	590.4	8.4	......	sw.	....
4:45 p. m....	713.8	18.8	44	s.	5.4	1314	650.9	14.6	......	ssw.	....
4:56 p. m....	713.8	18.2	46	s.	5.4	904	683.0	15.6	......	s.	....
5:05 p. m....	713.8	18.1	47	sse.	5.4	526	713.8	18.1	47	sse.	5.4
Sept. 30.											
7:34 a. m....	713.3	12.0	80	nw.	5.4	526	713.3	12.0	80	nw.	5.4
7:51 a. m....	713.5	12.6	77	nw.	5.4	934	679.9	12.0	......	wnw.	....
8:15 a. m....	713.6	12.4	72	nw.	4.9	1369	645.0	8.4	......	wsw.	....
8:30 a. m....	713.8	12.6	72	nw.	5.4	1932	602.4	5.0	......	wsw.	....
8:50 a. m....	714.0	13.1	68	nw.	8.0	1659	622.8	4.8	......	wsw.	....
9:15 a. m....	713.9	13.4	65	nw.	7.2	1323	648.6	6.3	......	wsw.	....
9:41 a. m....	713.8	13.8	56	wnw.	7.6	999	674.6	8.8	......	w.	....
9:55 a. m....	713.7	13.8	56	wnw.	7.2	526	713.7	13.8	56	wnw.	7.2

September 29.—Four kites were used, lifting surface, 25.2 sq. m. Wire out, 6000 m., at maximum altitude.

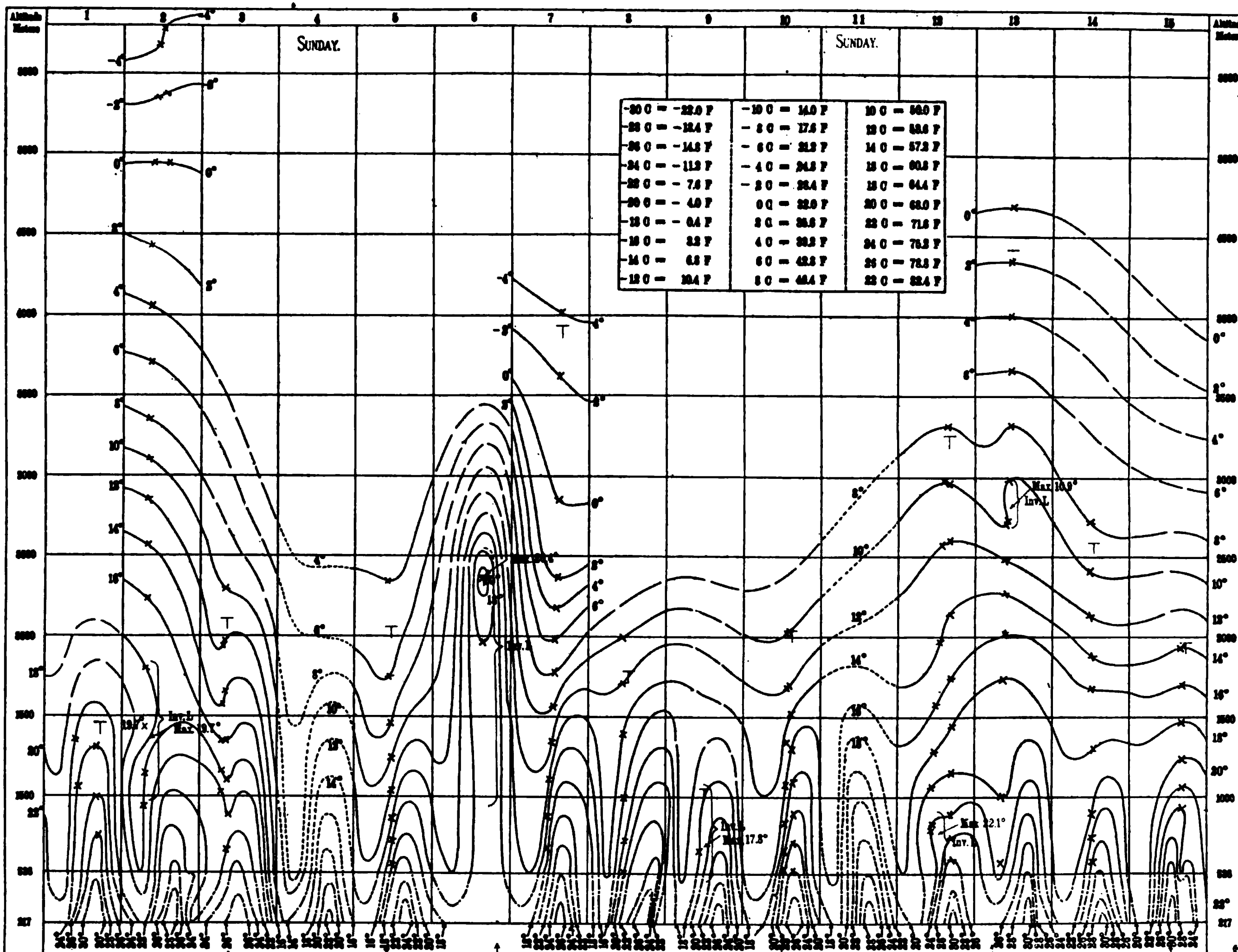
The sky was cloudless.

Areas of low pressure were central over Lake Huron and eastern Maine. Pressure was high over the Southern States.

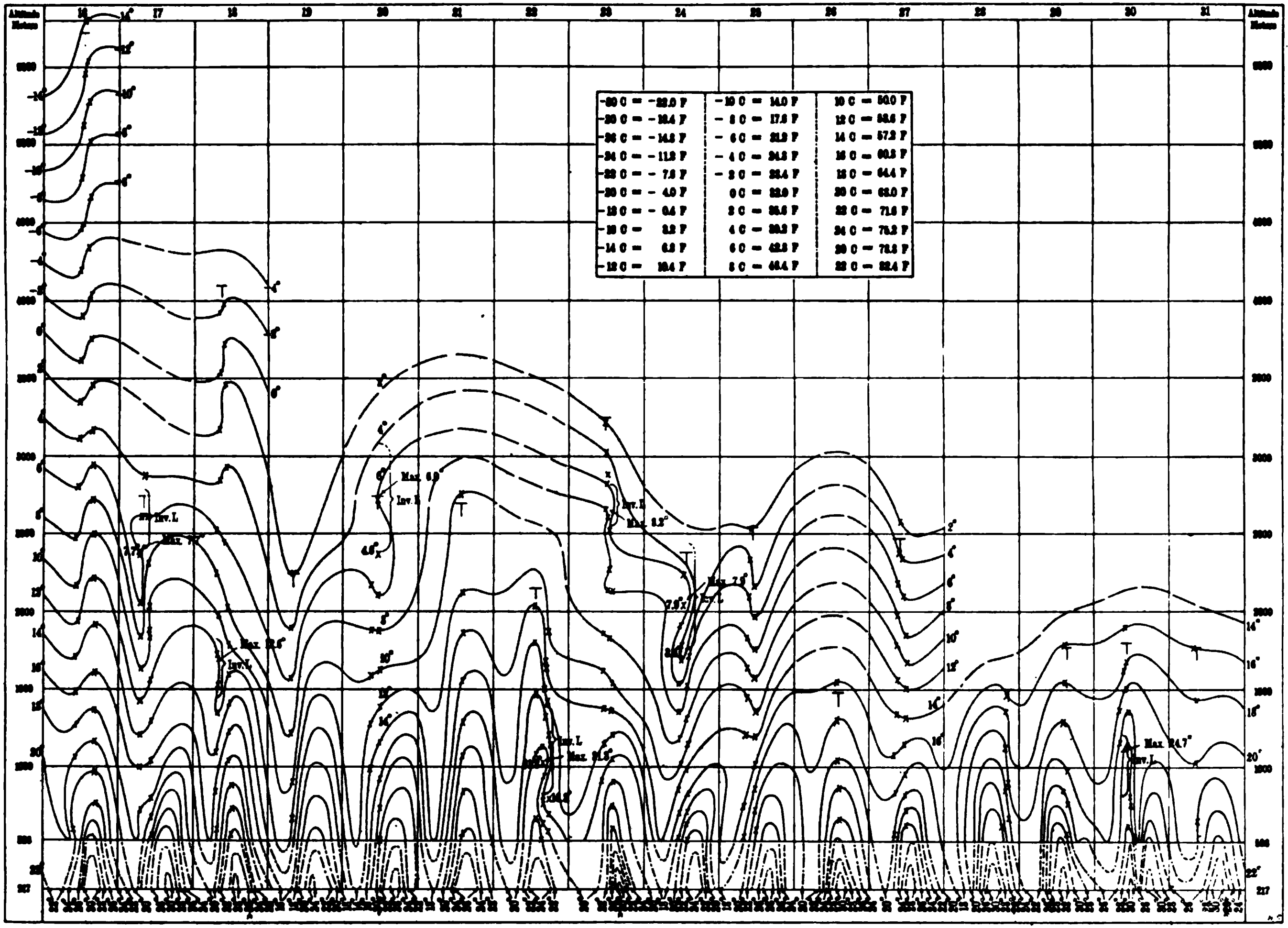
September 30.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 2000 m.; at maximum altitude, 1700 m.

At the beginning of the flight 3/10 St.-Cu. from the west-northwest. They diminished to 0 by 8:15 a. m. About 1/10 Cu., moving from the west-northwest were noted at 8:15 a. m. and had diminished to few by the end of the flight.

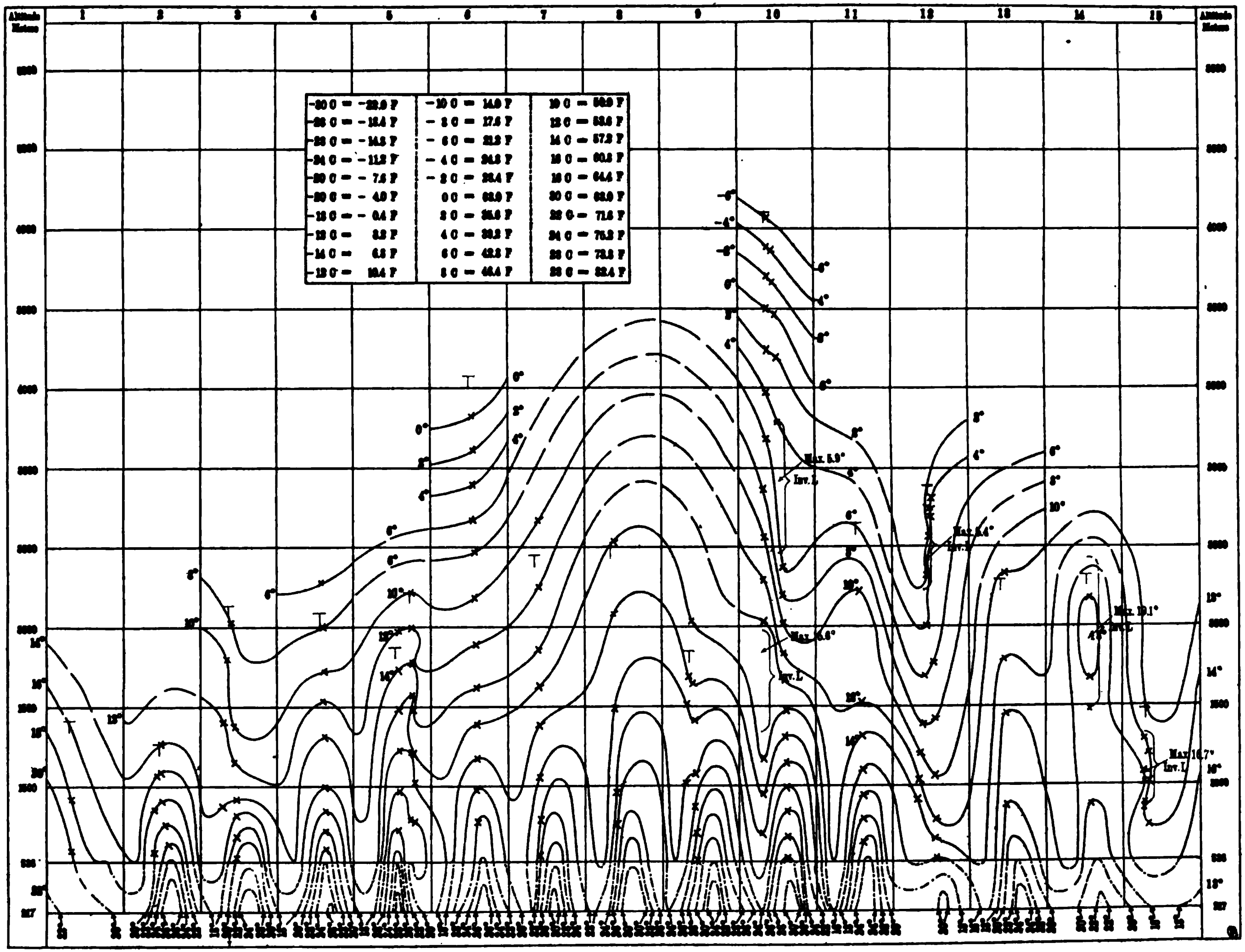
Low pressure was central over Ontario ard high pressure over Minnesota and eastern Texas.



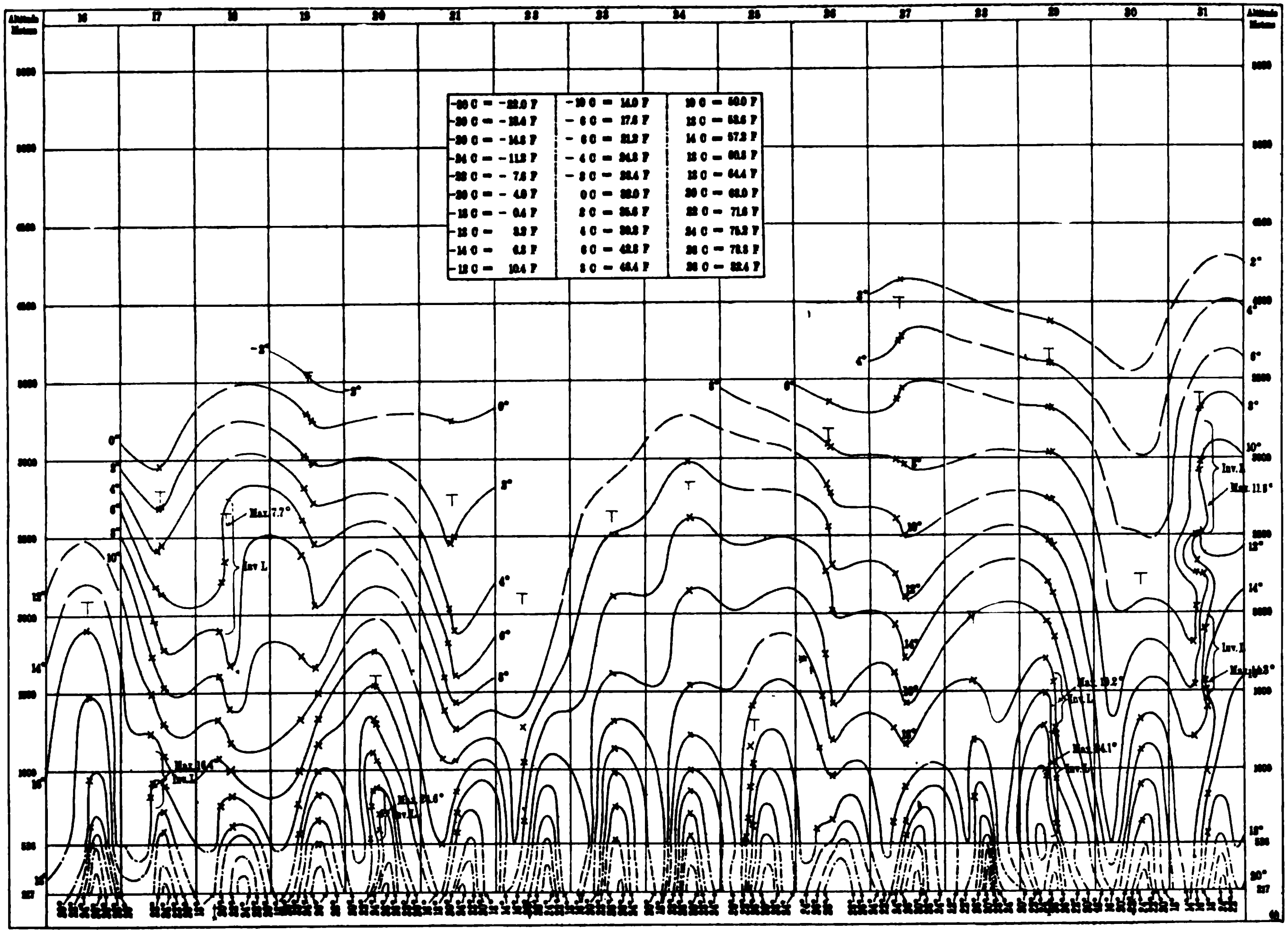
Upper air isotherms, July 1–15, 1909.



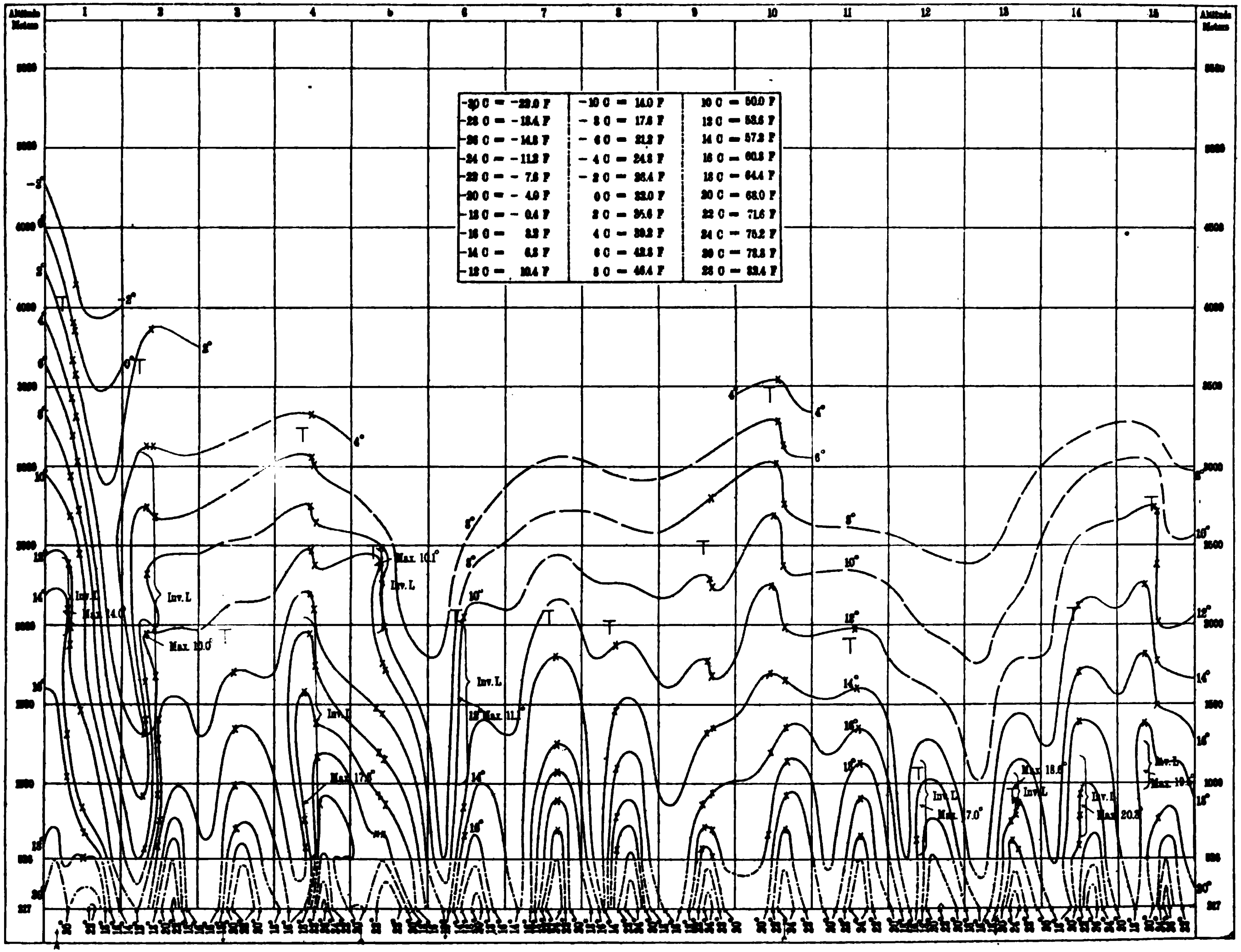
Upper air isotherms, July 16–31, 1909.



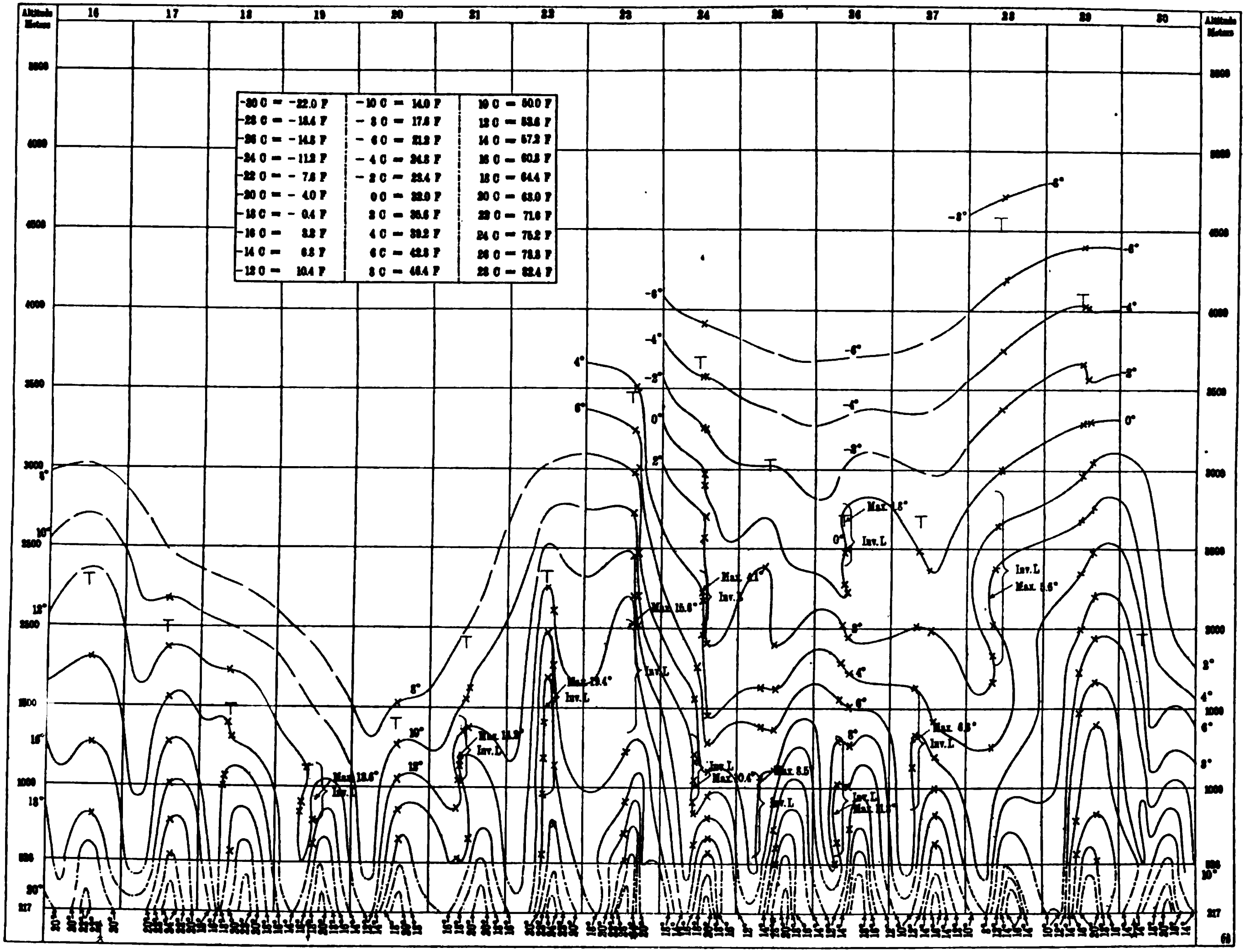
Upper air isotherms, August 1–15, 1909.



Upper air isotherms, August 16–31, 1909.



Upper air isotherms, September 1–15, 1909.



Upper air isotherms, September 16–30, 1909.

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CHIEF U. S. WEATHER BUREAU

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1910

CONTENTS.

CHARTS.

Closed April 8, 1910.

CLEVELAND ABBE,

Professor and Editor.

(I) THE UPPER ATMOSPHERE.

By J. H. Jeans.[1]

A simple consideration of the molecular mechanism of a gas will show that it is impossible for an atmosphere to be in adiabatic equilibrium throughout. For at the outer limit to the atmosphere, which is predicted by the equation of adiabatic equilibrium, the density would be zero and the probable free path infinite. At any height below this outermost layer, the temperature would be finite. Thus there would continually be molecules arriving at this supposed outer limit, having finite velocities and only infinitesimal probabilities of collision. The majority of these molecules would pass beyond the limit to the atmosphere predicted by the simple "adiabatic" theory, and form an outer atmosphere of molecules in free flight, practically undisturbed by collisions. A simple application of statistical mechanics will show that in this outer atmosphere the temperature will be constant, and the density will fall off exponentially with the height; this part of the atmosphere, at least, must be in isothermal equilibrium.

A brief calculation will show that the isothermal layer predicted by these considerations will start at most only a few meters from what would otherwise be the outer limit of the atmosphere. The pressure in the isothermal layer would be only a small fraction of a millimeter of mercury, and the temperature only a fraction of a degree above absolute zero.

So long as we consider only the molecular mechanism of the atmosphere, it is difficult to find reasons why the isothermal conditions should extend to any region, except a layer of the kind just described. The question assumes a different aspect when the interaction between the molecules and the ether—the radiating and absorbing power of the gas—is taken into account.

For if, at any instant, the adiabatic condition prevailed up to a point at which the temperature was zero, or about zero, then the layers at zero temperature would be losing no heat by radiation, but would be gaining heat by absorption of the radiation passing outward from the warmer interior layers. Thus the coldest layers would be gradually warmed, and the state we have imagined could not be permanent. For any state to be permanent the radiation and absorption of each element must be equal.

[1] Dated Princeton, N. J., March 17, 1909. Amplification of a part of a lecture delivered at Columbia University, February 16, 1909.

The mathematical theory of an atmosphere in radiation equilibrium has been recently given in a very valuable paper by Mr. E. Gold.[2] The author shows that "for an atmosphere uniform in constitution, the adiabatic state could not extend to a height greater than that at which $p = 1/2\ p_o$, where p_o is the surface pressure." When the atmosphere is not assumed to be uniform, the height to which adiabatic equilibrium can prevail may be increased. An approximate formula is introduced to represent the varying amounts of water vapor at varying heights, and it is then found that "if the atmosphere consists of two shells, the inner in the adiabatic the outer in the isothermal state: (1) the inner can not extend to a height greater than that for which $p = 1/4\ p_o$ (10500 meters); (2) the inner must extend to a height greater than that for which $p = 1/2\ p_o$ (5500 meters)."

The existence of an isothermal region above the adiabatic region has now been amply demonstrated. Mr. Gold's concise summary of the evidence, given in the paper already referred to, is so valuable that it may perhaps be permitted to quote from it at some length.

> The phenomenon was first noticed by M. Teisserenc de Bort, in a communication to the Société de Physique, in June, 1899. He found the average height at which the change began to be about 11 kilometers. In September, 1906, a series of ascents was made at Milan, in which the isothermal layer was reached at heights varying from 8 to 13 kilometers, and at temperatures between −40° C. and −65° C. Over Berlin in 1906 the height at which the layer was reached varied from 10 to 13 kilometers, and the temperatures were between −50° C. and −65° C., the average being −55° C. In England during 1907 the height of the layer varied between 8 and 15 kilometers, and the temperature between −30° C. and −60° C., the mean height being about 11 kilometers, and the mean temperature −47° C. The layer has also been reached in Lapland, near the Arctic Circle (and simultaneously at Trappes, near Paris) at heights varying from 8 to 12 kilometers; also by Rotch, in America, in latitude 39° N., where the average height appears to be greater than in Europe. There can be no question, therefore, of its being merely a local or temporary phenomenon.

Piecing together the indications of theory and the data of observation, it appears probable that we shall obtain a fair approximation to average conditions by assuming that the atmosphere is adiabatic up to a height of 10½ kilometers, that at this point the temperature is −53° C. (=220° Abs.) and the pressure is $1/4\ p_o$, and that beyond this the atmosphere is in isothermal equilibrium.

Chemical Constitution of the Upper Atmosphere.

The constitution of the atmosphere will be the same throughout the adiabatic atmosphere. Thus the constitution of the isothermal atmos-

[2] The isothermal layer of the atmosphere and atmospheric radiation. Proc. Roy. Soc., **82**, p. 43.

phere, at its contact with the adiabatic atmosphere, will be identical with that of the atmosphere at the earth's surface.

The following table gives the most recent values of the proportion of the constituents of the atmosphere at the earth's surface, all measured by volume:

Hydrogen[3]	1 in 100 000, or less.
Helium[4]	1 in 250 000.
Neon[4]	1 in 80 000.
Nitrogen	78.06 in 100.
Oxygen	21.00 in 100.
Argon[5]	0.93 to 0.95 in 100.
Krypton[6]	1 in 20 000 000.
Xenon[6]	1 in 170 000 000.

As we pass upward in the atmosphere we shall suppose the atmosphere to be in equilibrium under the action of gravity alone. Thus the density of each constituent will fall off exponentially with the height, at any rate so long as variations in the value of gravity are imperceptible. If v_0 is the number of molecules of any kind per c. c. *at the bottom of the isothermal atmosphere,* and v the number of molecules per c. c. at a height z in this atmosphere, we have the relation (J. H. Jeans, The Dynamical Theory of Gases, p. 315):

$$v = v_0 e^{-2h\, mg\, az/(a+z)}.$$

Here $2h$ is to be put equal to $1/RT$, where R is the gas constant ($=9.3\times 10^{-17}$), and T is the absolute temperature, here to be put equal to 220. Thus $-2hm$ is equal to 1.1×10^{-10} for hydrogen, and for other substances is proportional to their molecular weights. The heaviest constituents of the atmosphere fall off the most rapidly in density as we ascend, as in the well-known diagram of Ferrel. The value of g (gravity) at the base of the isothermal atmosphere is 980, while a, the radius of the sphere which forms this base, is 6.4×10^8. Substituting these numerical values, we can find the value of v corresponding to any values of v_0 and z.

The results are given in Table 1. We may take the total number of molecules at the base of the isothermal atmosphere to be 10^{19} per c. c., and from this we can calculate the values of v_0 for the separate constituents of the atmosphere. These are given in the first column. The values of v corresponding to different values of z are given in the remaining columns.

[3] Sir J. Dewar, Proc. Roy. Institution, 17, p. 223, and elsewhere.

[4] Sir W. Ramsay, Proc. Roy. Soc., 76, p. 114.

[5] Moisson, Comptes Rendus, 137, p. 600.

[6] Sir W. Ramsay, Proc. Roy. Soc., 71, p. 421.

TABLE 1.—*Number of molecules per cubic centimeter.*

(z is measured (in kilometers) from the *top* of the assumed adiabatic atmosphere at 10.5 kilometers above sea level.)

Gas.	Molecular weight.	Number per c. c. at height z (in kilometers).				
		$z=0$.	$z=20$	$z=80$.	$z=160$.	$z=800$.
Hydrogen	2	10×10^{13}	8×10^{13}	430×10^{11}	182×10^{11}	3×10^{10}
Helium	4	4×10^{13}	2.6×10^{13}	73×10^{11}	13×10^{11}	10^{6}
Neon	20	125×10^{13}	14×10^{13}	3×10^{11}	5×10^{7}	0
Nitrogen	28	$780\ 600\times10^{13}$	$42\ 900\times10^{13}$	520×10^{11}	35×10^{7}	0
Oxygen	32	$210\ 000\times10^{13}$	$7\ 000\times10^{13}$	25×10^{11}	0.3×10^{7}	0
Argon	40	$9\ 300\times10^{13}$	139×10^{13}	0.04×10^{11}	10^{3}	0
Krypton	81	0.05×10^{13}	10^{8}	0	0	0
Xenon	127	0.006×10^{13}	10^{4}	0	0	0
Total		10^{19}	5×10^{17}	10^{14}	2×10^{13}	3×10^{10}

The table shows at a glance how the heavier gases tend to sink to the bottom of the isothermal atmosphere, while the lighter ones rise to the top. The proportion of any light to any heavy constituent increases continually as we ascend, so that the proportion of a light gas, even though comparatively rare at the bottom, must necessarily exceed that of a heavier gas after a sufficient height. For instance, hydrogen passes nitrogen at about 85 kilometers up, while at 100 kilometers the hydrogen forms 90 per cent of the whole atmosphere, and at 800 kilometers, the atmosphere is entirely hydrogen, except for an infinitesimal trace of helium. (The table is calculated on the supposition that hydrogen forms one-hundred-thousandth of the atmosphere at its base. If any proportion other than this is ultimately found to be the true one, the figures for hydrogen must be altered accordingly, but the remainder of the table would, of course, stand unaltered.)

The helium in the atmosphere is at no point any great proportion of the whole. At about 95 kilometers the helium exceeds the nitrogen in amount, but is already exceeded about eightfold at this point by the hydrogen.

Neon attains to even less prominence. The proportion which it forms of the whole atmosphere reaches its maximum at a height of about 60 kilometers, at which the neon is about 1 per cent of the whole. The other monatomic gases contribute their maximum proportion at the base $z=0$, so that at no part of the [upper?] atmosphere is the argon greater than 0.93 per cent, while the krypton and xenon form only an infinitesimal fraction at the base and disappear altogether very soon.

The table has been calculated on the hypothesis that the upper atmosphere is at a uniform temperature of 220° Abs., and is in equilibrium under the action of gravity alone. Any observational test of the

results must, therefore, be regarded as a test of the accuracy, or truth, of these hypotheses.

The greatest height from which an actual sample of air has been taken is 9 miles (14½ kilometers). The sample was not found to differ appreciably from ordinary air, but as the adiabatic atmosphere has often been observed to extend to heights greater than this, this evidence is of no account. Besides this, there are two sources of indirect evidence, which at present seem to give hope of providing definite information—meteor trains and the aurora borealis.

Prof. C. C. Trowbridge states that some recent experiments of his own on gas phosphorescence seem to show that the origin of the persistence of luminosity of meteor trains is some form of gas phosphorescence. If this is so, it may be possible to obtain information as to conditions in the upper air by examining in the laboratory what conditions most closely reproduce the appearance of observed meteor trains. For instance, Professor Trowbridge states[7] that meteor trains are found to be most "persistent" in their duration when they are at a height of 50 to 60 miles. In the laboratory, the gas phosphorescence is found to be most persistent at pressure of 0.07 to 0.3 millimeter. Does this justify us in concluding that at a height of 50 or 60 miles the atmospheric pressure is from 0.07 to 0.3 millimeter? The column $z=80$, in our table, corresponds to a height of 56 miles above the earth's surface. The density here, as given by the calculation on which the table is based, is only 10^{14} molecules per c. c., corresponding to a pressure of only 0.02 millimeter at a laboratory temperature. It may be that there would be a better agreement if experiments on gas phosphorescence could be performed at a temperature comparable with that of the upper air and with a mixture of gases such as we should expect to find at a height of 50 to 60 miles (such, for example, as that given in the column $z=80$, of the table). If not, and if Professor Trowbridge is right in assigning the luminosity of meteor trains purely and solely to gas phosphorescence, then we shall be driven either to supposing that the temperature of the air at 50 miles is much lower than we have allowed for, or that the arrangement of the atmosphere is determined, in the main, by some agency other than gravitation.

These two sources of evidence, it will be seen, have not led to any definite information. The information derivable from the study of the aurora, although still less definite, is nevertheless very puzzling and somewhat disconcerting. Dewar believes the rosy color in the auroral

[7] The importance of the systematic observation of persistent meteor trains. The Observatory. Nov. 1908.

streamers to indicate the presence of neon, while other investigators attribute the green line in the auroral spectrum to krypton. Against these interpretations is the fact that other strong lines in the spectra of neon and krypton do not appear in the spectrum of the aurora. It is true that the proportion of neon in the atmosphere reaches its maximum at heights comparable with those at which the aurora is usually observed, but the proportion of krypton, if the atmosphere is arranged under gravity, ought to be absolutely infinitesimal at these heights. Consequently the presence of krypton, if ever it is definitely established as a fact, will be very difficult to interpret. It is not obvious, indeed, how it can be interpreted, except by the assumption, or discovery of some agency which will cause the heavy krypton molecules to rise, in opposition to gravity, until they form a far greater proportion of the atmosphere in the regions where the aurora occurs than they do at the surface.

LOSS OF PLANETARY ATMOSPHERE.

We are on surer ground when we discuss the dissipation of atmosphere produced by the molecular motions in the outermost layer of gas, and it is gratifying to find that the predictions of theory in these matters are absolutely borne out by observation.

To illustrate the problem, and the method of calculation, let us consider the particular instance of the earth's atmosphere. The outermost layers of this atmosphere must be in the condition already described at the beginning of the paper; they must consist of molecules in free flight, almost, or completely, undisturbed by collisions.

When the free path is sufficiently short, it may be treated as rectilinear, but the molecules we are now considering are in free flight for so long that the influence of gravity produces an appreciable curvature of the paths. For the majority of these molecules the paths may be treated as parabolic; a few rise to such heights that the variations in the value of gravity are perceptible, so that their orbits are elliptic; these molecules, while in flight, form in effect a series of infinitesimal satellites to the earth. A smaller minority describe hyperbolic orbits, and these molecules are lost to the earth's atmosphere forever. The problem of determining the rate of loss of planetary atmospheres amounts to calculating the number of molecules which arrive in regions in which the chance of collision is negligible, with velocities sufficient to carry them beyond the earth's attraction.

At a height of 2000 kilometers from the earth's surface, the number of molecules per cubic centimeter is of the order of 4×10^6 and the mean free path is consequently about 1400 kilometers. Thus the average

molecule which arrives at this layer may be expected to describe 1400 kilometers, without collision, unless, of course, it falls back into the denser layers of the atmosphere before it has traveled this distance. But, after 1400 kilometers, if these are described in a direction away from the earth, the gas is so rare that the chance of collision is negligible. We may, accordingly, suppose that molecules which cross in an outward direction a sphere at a distance of 2000 kilometers from the surface of the earth, and have a sufficient velocity to carry them beyond the earth's attraction, will be lost forever—the chance of their being turned back by a collision with another molecule is too small to be worthy of consideration.

The mean radius of the earth is 6.37×10^8 cms. The radius of the sphere we are now considering is therefore 8.37×10^8 cms. Calling this a, the smallest velocity c which will take a molecule out of the earth's sphere of action is given by

$$c^2 = \frac{2\gamma M}{a}$$

where γ is the gravitation constant, and M is the earth's mass. The product $M\gamma$ is known from the observed value of gravitation to be 4×10^{20}. On substituting this value, the value of c is found to be

$$c = 9.87 \times 10^5 \text{ cms. per sec.}$$

All molecules which arrive with velocities greater than this will describe hyperbolic orbits, and may be counted as lost to the earth; all molecules which arrive with velocities less than this will describe elliptic orbits, and so fall back into the atmosphere. The velocity c is to be measured relatively to axes moving with the center of the earth, but not rotating with the surface of the earth, whereas in discussing the motion of the molecules of the gas as produced by their temperature motion it is convenient to use axes which rotate with the earth. But the greatest velocity which can be due to the rotation of the earth is 5.28×10^4 cms. per second—about one-twentieth of c. The difference between the values of c referred to stationary and to rotating axes is about one-twentieth of the whole, or such as would be produced by a temperature difference of about 20° C. As it is not at present possible to estimate the temperature of the regions of the atmosphere now under discussion to within 20° C., it appears that nothing is to be gained by taking the rotation of the earth into account.

As soon as we agree to leave the earth's rotation out of account, another simplification is made possible. We have introduced a certain element of arbitrariness in taking a sphere of radius 2000 kilometers

greater than the earth as the limit of collision. As soon as we neglect the earth's rotation, this arbitrariness disappears; we find that our calculations will give very approximately the same result whatever sphere is taken, and moreover the result will depend only on quantities measured at the base of the isothermal atmosphere. These quantities we can, of course, evaluate with tolerable accuracy.

Let a_0 be the radius of the sphere which forms the base of the isothermal atmosphere,. and let ν_0 be the number of the molecules of any particular element per cubic centimeter at this sphere. The gravitational potential G at this sphere is given by

$$G=\gamma\frac{M}{a_0}$$

At any point in the isothermal atmosphere at which the gravitational potential is G', the number of molecules per cubic centimeter of the kind in question is

$$\nu_0\times e^{-2\,hm\,(G-G')}$$

and the velocity required to carry a molecule to beyond the earth's attraction is given by $c^2=2G'$. Thus the number of molecules which are lost per unit area per unit time is equal to the number which cross per unit area per unit time, with velocities greater than $\sqrt{2G'}$. It can be shown[8] that this number is

$$\frac{1}{2\sqrt{\pi hm}}\nu_0\,.\,e^{-2\,hm\,G}\,(1+2\,hm\,G')$$

so that the time t required for the atmosphere to lose an amount equal to a layer 1 centimeter thick at the base of its isothermal layer will be given by

$$t=\frac{2\sqrt{\pi\,hm}}{1+2hmG'}\,.\,e^{2\,hm\,G}\text{ seconds.}$$

The difference between G' and G is only one of a few per cent, and the error introduced into t on identifying G' with G is nothing like so great as that introduced in the evaluation of $e^{2\,hm\,G}$ from our ignorance of the exact value of h. Thus a formula which is as good as can be obtained, and is sufficiently accurate for our present purpose is

$$t=\frac{2\sqrt{\pi\,hm}}{1+2\,hm\,G}\,.\,e^{2\,hm\,G}\text{ seconds.}$$

Since $hm=\frac{3}{2c^2}$, where c^2 is the square of the mean velocities of the

[8] J. H. Jeans, The Dynamical Theory of Gases, page 319.

molecules, this may be written as

$$t = \frac{4.34}{c} \cdot \frac{e^{3G/c^2}}{1 + \frac{3\,G}{c^2}} \text{ seconds.}$$

For the earth $G = 0.486 \times 10^{12}$. The value of c^2 for hydrogen at 220°Abs., the temperature we are assuming for the isothermal atmosphere of the earth, is 2.7×10^{10}. Thus t is found to be about 10^{71} seconds, or 10^{64} years. At a temperature three times as great as this, namely 660° Abs., or 387° C., the value of c is 2.8×10^5, and the value of t is now only a few seconds. Thus if ever the temperature of our outer atmosphere were as high as 387° C., the escape of hydrogen would be appreciable.

The applicability of the formula is not, of course, limited to the earth. For any other planet the value of G is known with fair accuracy, being equal to $\gamma \frac{M}{a}$. In Table 2 are given the values of M, a, and G, for the various members of the solar system. In the three last columns are given the values of c, which would give to t the values of $t = 1$ day, 10 years, and 1 000 000 years, respectively. The former may be supposed to represent rapid dissipation, the second to represent moderate dissipation, and the last to represent inappreciable dissipation; all measurement being, of course, thought of in comparison with astronomical intervals of time.

TABLE 2.

Planet.	Mass. (Earth=1.)	Mean radius.	G.	c_1 (t=1 day.)	c_2 (t=10 years.)	c_3 (t=1 000 000 years.)
		Kilometers.				
Sun	333 000	696 000	1.91×10^{15}	1.4×10^7	1.3×10^7	1.1×10^7
Mercury	0.06	2 232	1.0×10^{11}	1.1×10^5	1.0×10^5	0.8×10^5
Venus	0.81	6 200	5.2×10^{11}	2.5×10^5	2.2×10^5	1.9×10^5
Earth	1.00	6 370	6.3×10^{11}	2.7×10^5	2.4×10^5	2.1×10^5
Moon	0.0123	1 740	2.8×10^{10}	6.0×10^4	5.4×10^4	4.6×10^4
Mars	0.108	3 400	1.3×10^{11}	1.25×10^5	1.12×10^5	0.94×10^5
Jupiter	317	70 000	1.8×10^{13}	1.4×10^6	1.3×10^6	1.1×10^6
Sat. I	0.005	2 000	1.0×10^{10}	3.5×10^4	3.2×10^4	2.7×10^4
Sat. II	0.007	1 770	1.6×10^{10}	4.5×10^4	4.1×10^4	3.4×10^4
Sat. III	0.028	2 900	3.8×10^{10}	7.0×10^4	6.3×10^4	5.2×10^4
Sat. IV	0.013	2 650	2.0×10^{10}	5.1×10^4	4.6×10^4	3.9×10^4
Saturn	95	58 700	6.4×10^{12}	8.6×10^5	7.7×10^5	6.5×10^5
Titan	0.02	2 340	3.4×10^{10}	6.6×10^4	5.9×10^4	5.0×10^4
Uranus	14	25 500	2.2×10^{12}	5.1×10^5	4.6×10^5	3.9×10^5
Neptune	16	27 000	2.4×10^{12}	5.3×10^5	4.8×10^3	4.0×10^5

This table must be used in conjunction with one giving the values of c for different gases at different temperatures as found in Table 3.

TABLE 3.—*Values of c.*

Gas.	Temperature.		
	−100° C.	0° C.	300° C.
Hydrogen	1.47×10^5	1.84×10^5	2.66×10^5
Helium	1.04×10^5	1.31×10^5	1.90×10^5
Water vapor	4.9×10^4	6.1×10^4	8.8×10^4
Carbon monoxid	3.9×10^4	4.9×10^4	7.1×10^4
Nitrogen	3.9×10^4	4.9×10^4	7.1×10^4
Oxygen	3.7×10^4	4.6×10^4	6.7×10^4
Argon	3.3×10^4	4.1×10^4	5.9×10^4
Carbon dioxid	3.1×10^4	3.9×10^4	5.7×10^4

The predictions of theory are seen to be in accordance with the facts in every case in which the facts are definitely known. The table explains the existence of atmospheres on Venus, the earth, and the superior planets. We see that Mars ought to retain water vapor and all heavier gases with certainty; the retention of helium must remain a matter of some doubt in our present ignorance of the Martian temperature. The absence of atmosphere on the moon appears to be fully explained by a consideration of the higher temperatures which must be reached on the illuminated side. An atmosphere has been observed on Titan, but this is explainable in view of its greater distance from the sun, the same consideration would appear to be adequate to account for the suspected atmospheres on two of Jupiter's satellites. Mercury again seems to be devoid of atmosphere, although the values of c_1, c_2, and c_3, are greater than for any of these satellites. But this is quite consistent with the high temperatures which might naturally be expected to occur on Mercury.

(II) THE CHANGES OF THE WIND WITH ALTITUDE.[1]

By ALFRED J. HENRY.

INTRODUCTION.

Some centuries ago the observation was made that the upper sails of a ship filled quicker than did the lower ones; probably thus was obtained one of the first notions that the speed of the wind increases with altitude. In recent times the use of the wind as a source of power for pumping water and other purposes has become almost universal, but notwithstanding such use of the wind for economic purposes our knowledge of the variation of wind speed with height has increased but little. The observations of wind velocity on the summit of the Eiffel Tower showed, some 20 years ago, that the diurnal variation of the velocity on the summit of the tower, 300 meters, was different from that obtained on the ground—an unexpected result, since it was then generally believed that the motion of the air at that height did not differ materially from that on the ground. At a later period the investigation of the lower layers of the atmosphere, by means of kites and balloons, furnished the ground work for the greater part of our present knowledge of the changes which ordinarily take place in the atmosphere with increase in height above sea level. Before the beginning of these later investigations, however, close observers of the motions of the clouds, especially in the cirrus level, showed that there was considerable divergence between the upper winds and those observed on the ground and in the lower cloud levels.[2]

The information yielded by kite observations, which is distinctly new, is the fact that the atmosphere is yet more stratified as regards wind direction than was supposed; that the divergence of the upper winds in many cases begins at a few hundred meters from the ground and continues until, in extreme cases, the upper winds differ by as much as 180° from the surface winds. In other words the atmosphere at times is formed of layers, not of very great vertical extent, each of which has a motion differing somewhat in azimuth from that of the adjoining layers. The differences generally proceed in a regular manner, that is the wind, with increase in altitude, turns successively in the same direction either to the right or to the left as the case may be, not first to the right and

[1] Read Dec., 1909, before Section D, American Association for the Advancement of Science, by permission of the Chief U. S. Weather Bureau.

[2] See a few references to recent literature appended to this memoir.

then to the left. Cases have been observed, however, when the wind first turned to the right and then to the left, or vice versa.

THE WINDS AT MOUNT WEATHER.

Mount Weather Reservation is situated near a summit of the Blue Ridge, 6 miles southwest of the railroad station at Bluemont, Va. It is the site of the research observatory of the United States Weather Bureau which was established there in November, 1904. The general trend of the ridge is about SW.-NE., and the altitude of the summit above the adjoining valleys—the Shenandoah on the west and the Loudoun on the east—is about 300 meters. The width of the Loudoun Valley is about 24 kilometers (15 miles); that of the Shenandoah about 40 kilometers (25 miles).

It is apparent at the outset that the winds at any point in a region whose topography is of broken character are not strictly comparable as to direction with those of a level, unbroken country. The well-known tendency of the surface winds to blow up and down a valley may be cited as an example of topographic effect. An isolated peak rising from a plain can have but little, if any, influence upon the direction of the wind; but the case is different when we have to do with a range of mountains, low in altitude to be sure, but with many lateral projections extending from the main ridge at various angles, as in that part of the Blue Ridge about Mount Weather. The observatory at Mount Weather is situated in a cleared spot on the top of the ridge with higher ground both to the northeast and the southwest. The removal of the timber from the immediate environment of the observatory accentuates somewhat the natural saddle in the ridge itself, and as a result the air, unimpeded by the friction of the forest cover, flows over the mountain, at times, with terrific speed.

THE DIRECTION OF THE WIND AT MOUNT WEATHER.

If the Blue Ridge were absent the direction of the wind at Mount Weather should, in general, accord with that observed at the relatively near-by stations, Washington, Baltimore, and Lynchburg. To see how the winds on the mountain correspond with those of low-level surrounding stations Table 1 was prepared. In this table will be found the percentage of winds from the eight principal points of the compass as determined from the twice-daily simultaneous observations made at the stations named during a period of nearly four years. About 2800 observations were used in getting the percentages. The results are

graphically shown in figs. 1, 2, 3, and 4, and the numerical values are given in Table 1.

TABLE 1.—*Percentages of winds from the N., NE., E., etc.*

Station.	N.	NE.	E.	SE.	S.	SW.	W.	NW.
Mount Weather, Va.	4	3	6	20	10	8	10	39
Washington, D. C.	13	12	6	10	16	12	7	24
Baltimore, Md.	14	10	9	6	13	17	11	20
Lynchburg, Va.	6	19	8	9	10	18	10	19

One is at once impressed by the undue preponderance of northwest and southeast winds at Mount Weather. From Table 1 it will be seen that 59 per cent of the winds at Mount Weather are from these directions, northwest and southeast, respectively, while for Washington the percentage is but 34; Baltimore, 26; and Lynchburg, 28. The winds which parallel the direction of the mountain ridge, viz, northeast and southwest, form but 11 per cent of the total winds, while the winds from the same directions at Washington amount to 24 per cent; at Baltimore, 27 per cent; and at Lynchburg, 37 per cent, or more than double the number at Mount Weather. It seems probable that the deficit of winds parallel to the general trend of the ridge is partly due to surface friction, the ridge being wooded, and partly to altitude. The altitude effect will be referred to later.

If now a wind-rose be constructed for the free air above Mount Weather, where surface friction is absent, it will be seen that upper air currents are considerably different from those which are observed on the mountain top or even at stations much nearer sea level; see fig. 5. It will be seen from that figure that the large percentage of northwest and southeast winds observed on the mountain top is not a feature of the circulation at 2800 meters, and that not more than 1 per cent of the southeast winds extend up to that altitude. The main drift of air is from the west and is rather symmetrically distributed between southwest and northwest.

Wind directions observed near sea-level, even when the observational area is small, are more or less discordant, owing probably to the effect of local topography. This is plainly seen at Lynchburg, Va., where there is an undue proportion of northeast winds, probably as the result of the observations being made in the valley of the James River, which, at Lynchburg, has a more or less easterly course. With these remarks we will proceed to the consideration of Table 2, wherein are given the wind directions observed in 685 kite flights at Mount Weather in 1908 and 1909.

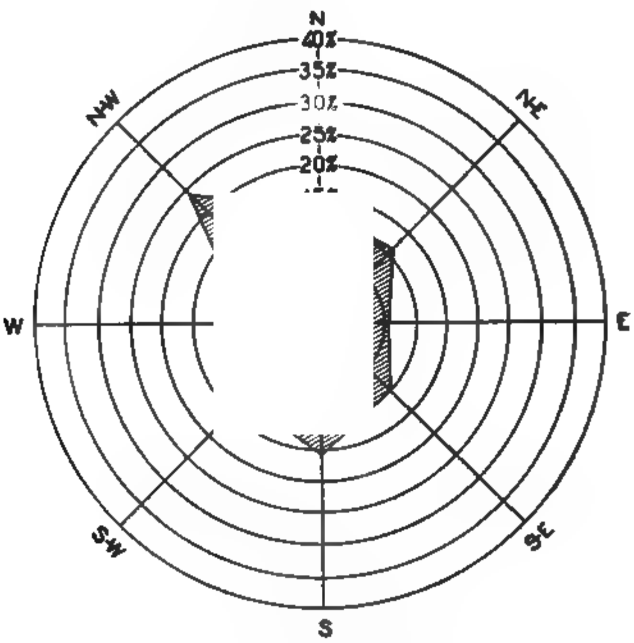

FIG. 1.—Wind-rose for Washington, D. C.

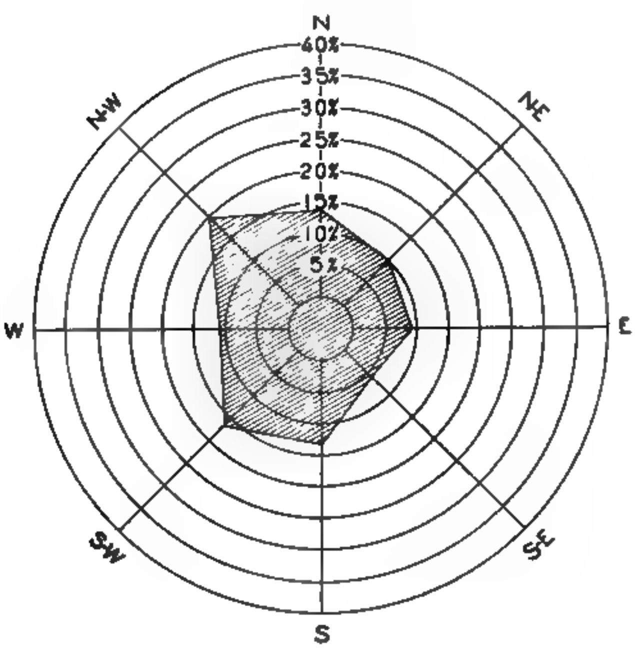

FIG. 2.—Wind-rose for Baltimore, Md.

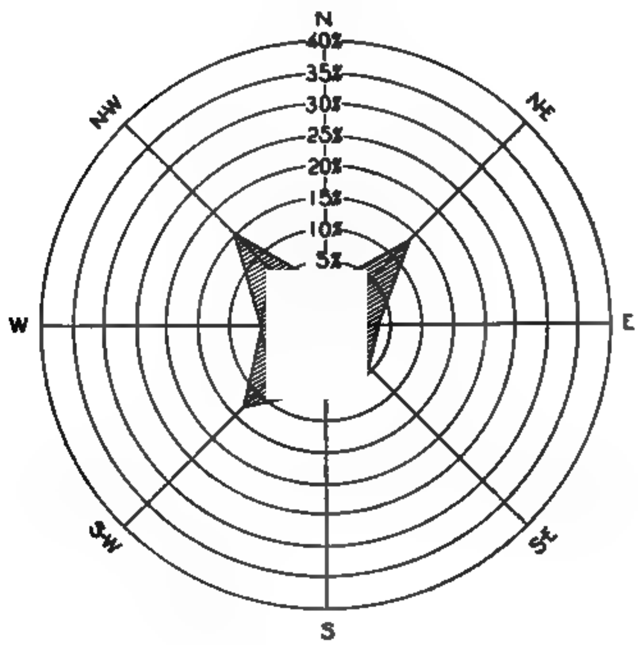

FIG. 3.—Wind-rose for Lynchburg, Va.

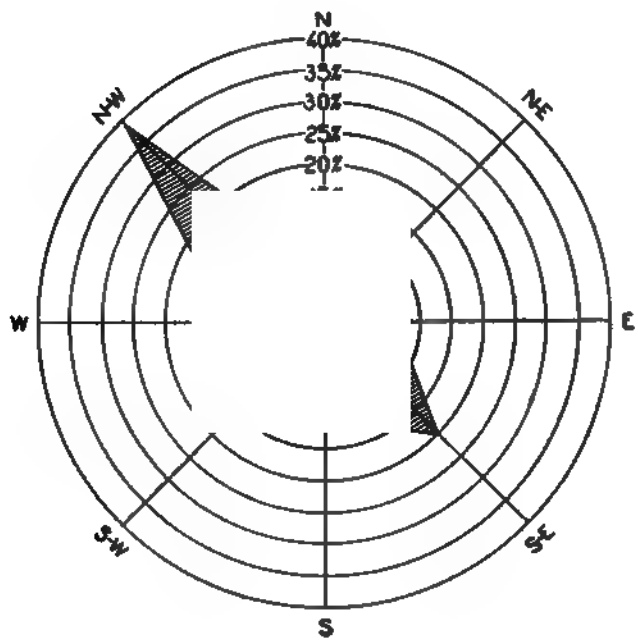

FIG. 4.—Wind-rose for Mount Weather, Va. (surface).

TABLE 2.—*Wind directions in 685 kite flights at Mount Weather, Va., 1908 and 1909.*

(All altitudes are above the kite reel at Mount Weather. Altitude, 526 meters.)

Wind direction.	Flights under 1000 meters.		Flights above 1000 meters.			Total.		Wind direction.	Flights under 1000 meters.		Flights above 1000 meters.			Total.	
	Surface.	Above.	Surface.	At 1000 meters.	Above 1000 meters.	Surface.	Above.		Surface.	Above.	Surface.	At 1000 meters.	Above 1000 meters.	Surface.	Above.
S.....	6	12	54	27	19	60	39	NNE	1	1	1	13	9	2	14
SSW.	0	8	5	32	21	5	40	NE.	3	3	13	20	12	16	23
SW...	5	2	37	80	60	42	82	ENE	0	2	4	6	5	4	8
WSW.	0	7	16	35	65	16	42	E...	13	5	13	13	13	26	18
W....	6	11	51	88	125	57	99	ESE	6	5	9	8	6	15	13
WNW	6	7	64	97	82	70	104	SE..	25	11	108	6	4	133	17
NW..	27	15	168	82	82	195	97	SSE.	3	6	11	10	2	14	16
NNW	3	6	10	42	34	13	48								
N....	1	4	16	21	26	17	25	Sums	105	105	580	580	565	685	685

FREQUENCY OF WINDS FROM THE SEVERAL POINTS OF THE COMPASS.

Column 1 of Table 2 shows the directions of the wind; columns 2 and 3 the directions at the surface and at the top of 105 small flights, none of which reached an altitude of 1000 meters above the station; columns 4, 5, and 6 show for 580 higher flights the wind directions at the surface, 1000 meters above, and at the top of the flight; and finally in columns 7 and 8 is given a summation of that which appears in the previous columns.

It should be remarked here that the surface winds in Table 2 are largely grouped around the eight principal points of the compass. The reason for this is that during the greater part of 1908 the direction of the surface wind was taken from the station anemograph, which records only to eight points of the compass. This method was changed in the latter part of 1908, and the direction is now observed to sixteen points of the compass, viz, N., NNE., NE., etc.

The excess of westerly over easterly winds in the kite flights, which are made mainly in the forenoon, is even greater than that found from the twice-daily telegraphic observations at 8 a. m. and 8 p. m. used in forming Table 1. At the surface, considering now only those flights which exceeded 1000 meters, 58 per cent of the winds were from a westerly quarter (SW. to NW., inclusive,) and 25 per cent were from an easterly quarter (NE. to SE., inclusive). Above 1000 meters 79 per cent of the winds were from a westerly quarter and only 7 per cent from an easterly quarter.

The distribution of the surface winds as recorded here and at European stations does not differ greatly, but the distribution above 1000 meters is markedly different as regards both frequency and altitude of

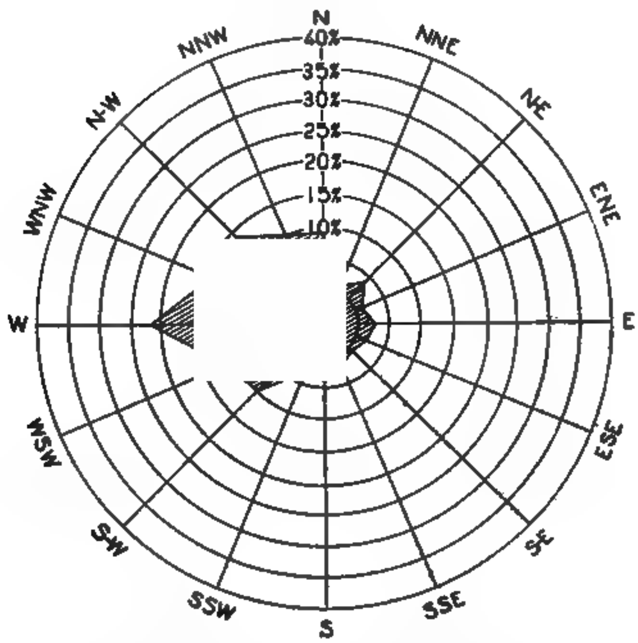

Fig. 5.—Wind-rose for Mount Weather, Va. (aloft).

easterly winds. At Hamburg, according to Dr. W. Köppen,[3] the easterly surface winds form 34 per cent of the whole, while at a height of about 2200 meters they form 26 per cent of the total winds observed. Easterly winds at European kite stations extend to about the same altitude as westerly, although they are not so frequent. For example, at the K. Preussischen Aeronautischen Observatoriums bei Lindenberg in 1907 and 1908 about 207 kite and balloon ascensions were made, in which an altitude of between 3 and 4 kilometers was reached. The winds in 60 per cent of these ascensions were westerly, and in about 20 per cent easterly.

At Mount Weather for the same period altitudes between 3 and 4 kilometers were reached about 141 times. In 88 per cent of these flights the winds were from a westerly quarter and in but 3 per cent from an easterly quarter. Furthermore easterly currents strong enough to raise kites above 4 kilometers at Mount Weather have been found but once in two years. On one other occasion a northeast wind was found which extended up to between 5 and 6 kilometers.

[3] Köppen, W. Die Windrichtung in 800 Drachenaufsteigen, Annalen der Hydrographie und Maritimen Meteorologie. XXXVI, Jahrgang 1908, Heft. II.

The shallowness of easterly winds on this continent as compared with European countries is probably one of the features inherent in the stronger circulation of the North American Continent. In the warm season when cyclonic and anticyclonic movements are at their minimum the easterly surface winds rise to their greatest altitudes in the atmosphere. They probably reach their maximum altitude in late summer and early autumn, especially when a cyclone is central along the Atlantic coast south of Mount Weather. It would be interesting in this connection to have soundings of the atmosphere in the northeastern quadrants of cyclonic areas, which move eastward over the Great Lakes.

Along the Atlantic coast from New England to Florida easterly winds are generally not of great force, the single exception being in the neighborhood of Nantucket, off the southern New England coast, where they frequently attain to considerable violence. This fact was long since established by the officials of the Forecast Division of the Weather Bureau, whose experience showed them that almost invariably the highest velocities came not with easterly winds, but after the shift of the wind to a westerly quarter. This experience is fully confirmed by the kite observations at Mount Weather. The wind at this place responds but slowly to the barometric gradients on the front of an approaching cyclone; it oftens happens that there is barely enough wind to lift the kites until within a few hours of the approach of the storm center. On the other hand, once in a great while a southeast wind of more than ordinary force is experienced. The increased wind force is held by the writer to be a measure of the storm's energy and an indication of increasing strength in its future path. Unfortunately it has never been possible to explore winds of this character by reason of the prevalence of fog and rain.

Divergence of the Upper Winds from the Lower Winds.

In Tables 3, 4, and 5 are given the differences between the upper winds and the lower winds, a turning to the right, as the hands of a clock move, being counted as positive, but to the left or counterclockwise, negative. There is a probable error in the absolute amount of turning which, in some cases, may amount to as much as 20°, for the reason, as before stated, that the surface winds for the greater portion of 1908 were read from the anemograph sheets which record directions to eight points of the compass only. Another source of error in the absolute amount of turning may be found in the fact that the direction of the surface winds in some cases may be partly determined by the

local topography of the mountain and to that extent differs from what it would be were it due to the atmospheric circulation alone. Otherwise the data are believed to be trustworthy.

One hundred and two short flights, that is flights in which the average altitude attained was about 674 meters above the mountain, have been considered and tabulated separately in Table 3. In 34 of them, or 33 per cent, the direction of the wind on the surface and at an average altitude of 674 meters was the same; in 13, or 12 per cent, the wind turned to the left; and in the remaining 55, or 54 per cent, to the right. At the height of 1000 meters above the station the direction of the wind was the same as at the surface in 26 per cent of the cases; in 20 per cent it turned to the left; and in the remaining 54 per cent to the right. Above 1000 meters there was no turning in 21 per cent of the flights, a turning to the left in 26 per cent, and to the right in 53 per cent of the cases. These results are brought together below.

Turning of the winds above Mount Weather with altitude.

Altitude above Mt. Weather.	No turning.	Turning to—	
		Left.	Right.
Meters.	*Per cent.*	*Per cent.*	*Per cent.*
674	33	13	54
1000	26	20	54
2446	21	26	53

These figures seem to indicate that the divergence of the wind increases with altitude, as does also a turning to the left. It would be interesting to know how much the turning of the wind observed in kite flights is real and how much is only apparent. For example, suppose that a flight on one day shows a decided turning to the right, as from SE. at surface to W. at 4000 meters. Suppose on the following day a turning to the left is shown as from NNW. to W. at the same altitudes. Query: the direction of the wind at 4000 meters being the same on both days have we not to do with a shifting of the wind in the lower layers of the atmosphere—a sort of readjustment to the conditions imposed by the gradients, rather than a real turning of the wind with increasing altitude?

The great preponderance of winds that turn to the left in the flights made at Mount Weather, as compared with those made at Hamburg, is worthy of attention. The turning of the winds with altitude, in this country at least, is intimately connected with the movements of cyclones

and anticyclones from west to east. The track of cyclonic areas, or depressions, is generally to the northward of Mount Weather, and therefore the observations made there refer in nearly all cases to the southern quadrant of a circular low, or V-shaped depression, as the case may be. Highs, on the other hand, pass almost directly over the station from a westerly quarter. The winds in the cirrus level, as shown by cloud observations, almost without exception come from a westerly quarter, and this statement is substantially true for Mount Weather whatever be the pressure distribution as indicated by the daily weather maps. For the levels, up to an altitude of about 3 kilometers, on the other hand, as is well known, the prevailing westerly winds are periodically interrupted by the eastward movements of highs and lows. In the front of a high the winds are NW. to W., and there is reason to believe they have a small downward component. As the center of the high passes to the eastward of Mount Weather a period of light winds, mostly east to south, sets in, and these winds have, there is also reason to believe, a small upward component. The winds therefore may be conceived of as belonging to two classes, viz, strong westerly winds which extend up to heights of probably 9 to 10 miles, and weak east to south winds, which, as the kite records at Mount Weather abundantly show, extend to but a small height above the station. In the transition from one system of winds to the other there is the greatest turning, as one might naturally expect.

TABLE 3.—*Divergence of the winds, at an average altitude of about 674 meters above Mount Weather, from the winds at the surface. (Short flights under 1000 meters, 1908–1909.)*

Direction surface.	−135°	−112°	− 90°	− 67°	− 45°	− 22°	0°	+ 22°	+ 45°	+ 67°	+ 90°	+112°	+135°	Total	Mean Angle
S							3	2	1					6	
SSW								1						1	
SW								1	2					3	
WSW														0	
W							5	1	1					7	
WNW					1		1	2	1	1				6	
NW				1		4	12	4	1	1	1			24	+ 6
NNW							1	1						2	
N		1	1				1							3	
NNE															
NE							1		1					2	
ENE															
E					1	1	3	2	2					9	
ESE						1	1	2	1					5	
SE				1		1	6	5	9	4	1	2	1	30	+ 38
SSE								2	2					4	
Sums		1	1	2	2	7	34	23	21	6	2	2	1	102	

TABLE 4.—*Divergence of the winds, at an average elevation of 1000 meters above Mount Weather, from the surface winds. Year.*

Direction surface.	−135°	−112°	−90°	−67°	−45°	−22°	0°	+22°	+45°	+67°	+90°	+112°	+135°	Total	Mean Angle
S			1		2		5	6	25	7	9		1	56	+ 44
SSW								4	1	4				9	+ 45
SW					1	3	10	6	16	8	1		1	46	+ 30
WSW				1			3	10	4	1				19	+ 21
W				1	2	3	25	16	4					51	+ 6
WNW						6	41	16	5		2			70	+ 9
NW	1	2	5	6	16	35	47	28	11	7	3			161	− 5
NNW		1		1	1		3			1				7	− 22
N					3	1	4	1	6		1			16	+ 14
NNE														0	0
NE			2	2	1		2	1			1			9	− 27
ENE							2		2					4	.....
E		1			2		4	2	1				1	11	+ 2
ESE							1		1	2	1	5		10	+ 83
SE			3	2	5	4	4	5	14	13	38	11	6	105	+ 61
SSE						1		3	2	4		1		11	+ 47
Sums	1	4	11	13	33	53	151	98	92	47	56	17	9	585	.....

TABLE 5.—*Divergence of the winds, at an average elevation of 2446 meters above Mount Weather, from the surface winds. Year.*

Direction. surface.	−135°	−90°	−67°	−45°	−22°	0°	+22°	+45°	+67°	+90°	+112°	+135°	+157°	Total	Mean Angle
S		1		1		2	4	13	16	11	3			51	+ 58
SSW							1	1	2					4	.....
SW			1	1	1	5	9	10	7	1				35	+ 31
WSW			1				8		1					10	.....
W				3	5	22	7	3	2					42	+ 4
WNW			1	4	11	19	14	5	1	1				56	+ 4
NW		8	6	29	33	41	17	12	4	2				152	− 12
NNW			1		1	2		1			1			6	.....
N				1	2	4	2	2		1				12	.....
NNE		1												1	.....
NE		1		1	1	2								5	.....
ENE						1								1	.....
E	1			2	2	4	2	2	1	1				15	.....
ESE						1			1	2	3	2		9	.....
SE		3	1	1	2	1		9	10	21	17	25	4	94	+ 90
SSE			1				1	2				1		5	+ 36
Sums	1	14	12	43	58	104	65	60	45	40	24	28	4	498	.....

TURNING TO THE RIGHT (CLOCKWISE).

Whatever the cause of the turning of the wind may be it is nearly always observed at Mount Weather in connection with a certain definite pressure distribution. A number of examples of the pressure distribution under which the southeast surface winds turn to the right with increase in elevation are given in Table 6.

As may be seen from Table 6 the wind turns sharply to the right in the transition zone between a retreating high and an advancing low. The particular type in which this turning is most pronounced may be remembered by the fact that the area of high pressure is east and the area of low pressure west of Mount Weather. The reverse condition, viz, a turning to the left, occurs under a pressure distribution exactly opposite,

viz, high pressure to the west and low pressure over Mount Weather, or to the east. The probable succession of the winds with altitude, in the type of pressure distribution first named, and for the region about Mount Weather, is northeast to east at sea level, southeast at the altitude of Mount Weather (526 meters), south at an altitude of about 851 meters, southwest between 1126 and 1526 meters, and west at still greater altitudes. The depth of the surface southeast winds above Mount Weather is, on the average, probably not more than 300 meters.

TABLE 6.—*Turning of the wind to the right.*

Date.	From	To.	Deg.	Position of high.	Position of low.
High pressure is east-northeast of Mount Weather, and the low pressure is west.					
1908.					
February 5....	se.	sw.	90	Crest over New England......	In Mississippi Valley.
February 10....	se.	wsw.	112	......do......................	In Rocky Mountain region.
February 11....	se.	sw.	90	......do......................	Do.
February 12....	se.	wsw.	112	......do......................	In Missouri Valley.
February 13....	se.	nnw.	167	......do......................	In Lake region.
February 25....	se.	sw.	90	......do......................	In Mississippi Valley.
December 30...	se.	sw.	90	......do......................	Over Lake Superior.
March 17.......	se.	w.	135	......do......................	In Lake region.
January 17.....	sse.	w.	112	Sn. New England to Texas....	In upper Lake region.
January 20.....	se.	w.	135	Along Atlantic coast..........	British Northwest.
December 24...	sse.	w.	112	......do......................	Over Lake Superior.
High central over Mount Weather.					
January 10.....	se.	sw.	90	Axis N/S over station.........	In Mississippi Valley.
January 31.....	se.	w.	135	......do......................	In Arkansas.
February 18....	s.	sw.	45	......do......................	Do.
High southeast or south of Mount Weather.					
December 14...	sw.	nw.	90	Crest SE. over Carolinas......	Indefinite.
January 25.....	w.	wnw.	22	Over north Florida...........	Over Ontario.
January 1......	sw.	w.	45	Over Georgia..................	Over Gulf of St. Lawrence.
February 3.....	sw.	w.	45	......do......................	Do.
March 28.......	s.	w.	90	Over Florida..................	Over Lake Ontario.
January 4......	s.	sw.	45	Over Carolinas................	Over upper Lakes.
January 15.....	s.	wsw.	67	......do......................	Do.

Under the conditions above described westerly winds make a large angle with the surface isobars, amounting in many cases to nearly 90°. While the movement of the air currents in the cirrus level over Mount Weather is almost directly at right angles to the isobars surrounding an area of high pressure, whose longer axis extends in a N./S. direction, it is not a little surprising to find a similar direction prevailing at so low a level as 2 and 3 kilometers.

The application of these facts to the problem of forecasting the weather is about as follows: When areas of low pressure approach Mount Weather from the west the diminished pressure in the Mississippi and Ohio valleys causes an inflow of air to that region from the region of high pressure to the eastward, which inflow first begins along the summit of the Appalachians as a southeast wind. The air over the Piedmont

region to the eastward is as yet undisturbed by the barometric gradients of the approaching low. The temperature of the lower air layers in that region, moreover, is relatively low, both by reason of slow descent in the area of high pressure with which it is associated, and as the result of intensified nocturnal radiation due to the dryness of the air. On these occasions the temperature at Mount Weather with a southeast wind is somewhat higher than in the adjoining valleys. The indraught of air toward the region of low pressure, which, as before stated, begins at Mount Weather as a southeast wind of little vertical extent, veers to the south and southwest, as the center of the depression approaches the meridian of Mount Weather, and thus becomes a surface wind from the south and southwest. The southerly winds being transported from lower latitudes are, of course, at a higher temperature than the air which had previously occupied the valleys below Mount Weather. As the surface air now moves in a direction parallel with the longer axes of the valleys it rapidly mingles with and, to a certain extent, replaces the hitherto undisturbed cold air. The effect of the Appalachians then is evidently to delay about 24 hours in special cases the rise in temperature, which ordinarily attends the approach of a barometric depression from the southwest.

The southeast wind, as before stated, doubtless has a small upward component in addition to the upward motion caused by impact on the mountain side. It must soon meet and mingle with the ever-prevalent and stronger westerly winds at a relatively small altitude. The direction in which these upper currents may be flowing, whether southwest, west-southwest, or west, probably determines in a measure the amount of divergence between the upper westerly and the lower easterly winds.

TURNING TO THE LEFT (ANTICLOCKWISE).

As previously stated the turning of the upper winds to the left is most generally found in the transition zone between an eastward moving depression and an area of high pressure advancing from the west. This turning has been observed almost in the center of the southwest quadrant of the low and seems to be greater near the center than on the outer edges of the depression. In the accompanying table (No. 7), a number of examples are given. While these can best be understood by reference to the daily weather maps special attention is directed to the pressure distribution on February 6 and 26, 1908, and on December 7, 1908, viz, a chief depression in the Lake region with a secondary disturbance over the region directly to the eastward of Mount Weather. The kite flights on these dates showed that the surface wind from the northwest extended

but a short distance above the mountain, and that higher up the air was moving from the southwest and west-southwest in obedience to the circulation proper to the chief depression.

TABLE 7.—*Turning of the wind to the left.*

High pressure west, low pressure east or north of Mount Weather.

Date. 1908.	Wind. Surface.	Wind. Aloft.	Angle.	Position of highest pressure.	Position of lowest pressure.
Feb. 26...	nw.	sw.	90°	Upper Mississippi Valley...	Main depression over Lake Superior, secondary over Maryland.
Feb. 6....	nw.	wsw.	67	Upper Mississippi Valley and Texas.	Main depression over Lake Huron, secondary over Maryland and Pennsylvania.
Dec. 7....	nw.	sw.	90	Kansas....................	Main depression over Lake Huron, secondary over Maryland.
Feb. 15...	nw.	wsw.	67	West of Rocky Mountains..	Over Lake Ontario.
Feb. 27...	nw.	sw.	90	Upper Mississippi Valley...	Off New England coast.
Mar. 7....	nw.	w.	45	South and west...........	Over St. Lawrence Valley.
Dec. 8....	nw.	w.	45	Lower Mississippi Valley...	Over Gulf of St. Lawrence.
Dec. 1....	nw.	w.	45	Western Nebraska.........	In St. Lawrence Valley.
Mar. 16...	nw.	w.	45	Upper Mississippi Valley...	Over Gulf of St. Lawrence.
Mar. 24...	nw.	w.	45	......do....................	Do.
Jan. 30...	nw.	w.	45	Lake Ontario.............	Wyoming.
Jan. 22...	nw.	wnw.	22	Middle Mississippi Valley..	Over Gulf of St. Lawrence.
Jan. 29...	nw.	wnw.	22	......do....................	Trough off Atlantic coast.
Mar. 9....	nw.	wnw.	22	......do....................	Do.
Mar. 19...	nw.	wnw.	22	......do....................	Off south New England coast.
Feb. 7....	nw.	wnw.	22	Upper Mississippi Valley and Texas.	Over Gulf of St. Lawrence.
Mar. 3....	nw.	wnw.	22	Upper Lake Region........	Off south New England coast.
Dec. 16...	nw.	wnw.	22	......do....................	Over Gulf of St. Lawrence.
Dec. 25...	wnw.	w.	22	In Colorado...............	Over Georgian Bay.
Jan. 8....	w.	wsw.	22	......do....................	In St. Lawrence Valley.

The turning of the wind to the left with altitude is important information to the forecaster since it at once shows the depth of the cold northwest wind, and from this information reasonably correct inferences may be drawn as to the fall in temperature at the ground in the next 24 hours. The temperature in the rear of a depression naturally falls, but the amount of the fall will be less the shallower the stratum of northwest winds. If, on the other hand, the upper winds were uniformly from the northwest up to an altitude of say 2 kilometers, then a relatively greater fall in temperature may be expeeted. These three cases illustrate quite clearly the formation of secondary cyclones within a parent cyclone, a not infrequent occurrence in the eastern part of the United States.

DIVERGENCE OF THE WINDS ALOFT WITH SEASON.

The data of Tables 4 and 5 have been arranged according to season. The divergence of the winds at an altitude of 1000 meters above Mount Weather during the cold season, viz, November to March, is shown in Table 8 and during the warm season, April to October, in Table 9. The percentage of winds at the above-named elevation which show no

divergence from the surface winds is in the cold season 27, in the warm season 23; showing that the turning of the wind is not materially affected by season. The amount of the divergence, however, is greatest in winter, as will be seen from the data in column "Mean angle." The chief point of difference between the seasons is to be found in the entire absence of winds from the east above the 1000-meter level in the cold season. See Table 10. The winds of the winter in the middle latitudes in the United States, as is well known, are strong and persistent from a westerly quarter. In the warm season the general circulation becomes much weakened, and, at times, there is a tendency toward more or less complete stagnation in the lower layers of the atmosphere. At such periods feeble easterly winds have been observed at altitudes greater than 1000 meters. See Table 11.

TABLE 8.—*Divergence of the winds at an average elevation of 1000 meters above Mount Weather, from the surface winds. (November to March, inclusive.)*

Direction surface.	−135°	−112°	−90°	−67°	−45°	−22°	0°	+22°	+45°	+67°	+90°	+112°	+135°	Total	Mean Angle
S								4	16	4	6			30	+ 53
SSW								2		4				6	+ 52
SW							5	4	13	5				27	+ 37
WSW								8	1	1				10	+ 29
W						2	10	7						19	+ 6
WNW						4	31	12	1		1			49	+ 6
NW		1		4	9	15	28	14	4	2				77	− 6
NNW							1							1	
N					2	1			1					4	
NNE														0	
NE															
ENE									2					2	
E									1					1	
ESE										1	1	4		6	
SE						1			6	3	25	5	4	44	+ 86
SSE								2	0	2		1		5	
Sums		1		4	11	23	75	53	45	22	33	10	4	281	

TABLE 9.—*Divergence of the winds at an average elevation of 1000 meters above Mount Weather, from the surface winds. (May to September, inclusive.)*

Direction surface.	−135°	−112°	−90°	−67°	−45°	−22°	0°	+22°	+45°	+67°	+90°	+112°	+135°	Total	Mean Angle
S			1		2		5	1	3	2	3			17	
SSW								1						1	
SW					1	1	4	2	2	2	1			13	
WSW				1			1		3					5	
W				1	2		13	8	3					27	
WNW						1	3	4	4		1			13	
NW	1	1	3	2	4	11	8	10	6	3	2			51	− 4
NNW		1		1	1		2			1				6	
N					1		2		5					8	
NNE														0	
NE			2	2	1		1	1			1			8	
ENE							2							2	
E		1			2		2	1					1	7	
ESE							1			1				2	
SE			2	2	3	4	3	3	5	5	8	6	2	43	+ 41
SSE						1		1	1	2				5	
Sums	1	3	8	9	17	18	47	32	32	16	16	6	3	208	

TABLE 10.—*Divergence of the winds at an average elevation of 2306 meters above Mount Weather, from the surface winds. (May to September, inclusive.)*

Direction surface.	−135°	−112°	− 90°	− 67°	− 45°	− 22°	0°	+ 22°	+ 45°	+ 67°	+ 90°	+112°	+135°	Total	Mean angle
S			1				2	1	4	7	3	1		19	+ 51
SSW								1						1	
SW				1	1		1	1	3	1				8	
WSW				1				2		1				4	
W					2	4	13	4	1	2				26	+ 3
WNW					2	2	5	4	3	1	1			18	+ 14
NW			2	4	10	11	8	7	7	2				51	− 12
NNW				1		1	1		1					4	
N					1	1	3	2	1					8	
NNE			1											1	
NE			1		1		2							4	
ENE							1							1	
E	1				1	1	3	2						8	
ESE							1				1		1	3	
SE			2	1	1	1	1		5	2	7	7	3	30	+ 60
SSE				1				1	1					3	
Sums	1	......	7	9	19	21	41	25	26	16	12	8	4	189	......

TABLE 11.—*Divergence of the winds at an average elevation of 2524 meters above Mount Weather, from the surface winds. (November to March, inclusive.)*

Direction surface.	−135°	− 90°	− 67°	− 45°	− 22°	0°	+ 22°	+ 45°	+ 67°	+ 90°	+112°	+135°	+157°	Total	Mean angle
S							1	6	5	7	2			21	+ 70
SSW								1	2					3	+ 60
SW						3	7	6	5	1				22	+ 39
WSW							3							3	+ 22
W					1	8	2	1						12	+ 5
WNW				1	7	11	10	2						31	+ 4
NW		4	1	14	16	21	7	4	1					68	− 15
NNW						1								1	
N						1								1	
NNE															
NE															
ENE															
E								2		1				3	+ 60
ESE										1	3	1		5	+112
SE								2	3	13	9	15	4	46	+111
SSE								1				1		2	
Sums	......	4	1	15	24	45	30	25	16	23	14	17	4	218	......

Comparing the observations of Tables 8 and 9 with similar observations made near Hamburg and discussed by Dr. Köppen[4] the following important differences appear: (1) The turning to the left is much more frequent at Mount Weather than at Hamburg. (2) The absence of easterly winds at an altitude of 1000 meters above Mount Weather in the cold season is not paralleled at Hamburg, where 32 per cent of the winds at 1000 meters come from an easterly quarter in the cold season.

[4] Loc. cit.

INCREASE OF WIND VELOCITY WITH INCREASE OF ALTITUDE.

The observations available for the investigation of this subject are as yet quite meager. For a comparison of the speed of the surface winds over a modern city with the winds observed at varying distances aloft up to 300 meters, the Eiffel Tower series is probably the best available.

Comparative wind velocities—Paris and Eiffel Tower.

	Paris. (21 m.)		Eiffel Tower. (300 m.)	
	m. p. s.	*m. p. h.*	*m. p. s.*	*m. p. h.*
Winter	2.39	5.4	9.85	22.0
Spring	2.24	5.0	8.55	18.9
Summer	2.05	4.5	7.77	17.3
Autumn	1.90	4.3	8.76	19.6
Year	2.15	4.8	8.71	19.5

These records show that the wind velocity at the top of the Eiffel Tower is nearly four times as great as at the general level of the tops of houses in the city of Paris.

The measures of wind velocity made in the free air above the Blue Hill Observatory, Prof. A. Lawrence Rotch, Director, also show a very marked increase in the speed of the wind in the first 500 meters above the ground, and this result is confirmed by the records of the Prussian Aeronautical Observatory at Lindenberg, Germany, Dr. R. Assmann, Director. The increase in the free air, however, is not so great, as shown by the Eiffel Tower records, being only about twofold greater at 500 meters than at the surface. The values for Lindenberg and Blue Hill follow:

Comparative wind velocities—Lindenberg and Blue Hill.

Altitude.	Lindenberg. (Alt. 122 m.)		Blue Hill. (Alt. 195 m.)	
Meters.	*m. p. s.*	*m. p. h.*	*m. p. s.*	*m. p. h.*
Surface	4.9	11.0	4.2	9.4
500	2.9	20.6	8.7	19.5
1000	9.5	21.3	9.1	20.4
1500	9.2	20.6	10.7	23.7
2000	9.7	21.7		
2500	10.5	23.5		
3000	11.3	25.3		

BIBLIOGRAPHY OF BROUN'S LAW.

The literature relative to "Broun's Law," expressing the deflection of winds to the right as we ascend, is already quite extensive. Among the papers that more readily occur to the writer are:

J. Allan Broun—Results of meteorological and magnetic observations at . . . Makerstoun, Scotland. Trans. Royal Soc., Edinburgh, 1845, **17**: 300. 1848, **18**: 439–441. 1849, **19** (pt. 2): 102–104.

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Rev. W. Clement Ley—Laws of the winds prevailing in western Europe. Part 1. London, 1872, p. 149, 156.

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O. T. Sherman—Monthly Weather Review, 1880, July, p. 15.

E. D. Archibald—1884 and 1885, Experiments with Biram's anemometer attached to kites.

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(III) NOTE ON THE INTERPRETATION OF LAINE'S RAINBOW OBSERVATIONS.

By W. J. HUMPHREYS. (Dated March 30, 1910.)

An interesting paper by Laine[1] has recently appeared on the influence of thunder on raindrops.

During the progress of a favorably situated thunderstorm Mr. Laine observed well-defined primary and secondary rainbows, the colors and curvature of which changed in a quivering or vibratory manner at every peal of thunder. These phenomena were not noticed at the moment of the lightning discharge, but almost exactly at the instant when the thunder was heard.

According to the theory of the rainbow, as given by Pernter,[2] just such changes as these would follow sufficiently rapid alterations in the sizes of the raindrops concerned in the formation of the bows.

Interpreting the changes noted in accordance with the theory of the rainbow, Laine states that, while his observations are not sufficiently exact to permit of a calculation of the amount of increase, they do, nevertheless, show that the drops grow in size under the influence of acoustical shaking; and that this increase is inconceivable, except as a result of the coalescence of two or more droplets.

This hypothesis is so seductively pretty that it has received wide attention, though it logically supports the discredited notion that noise is efficient as a producer of rain.

It seems well, therefore, to consider whether the increase in the size of the raindrops, demanded by the observed phenomena, must be attributed to air vibrations.

The amplitude of swing of an air particle, under the influence of thunder, is small when the distance from the lightning is as much as a 1000 feet or more. This is evident from the fact that windows are rarely, if ever, broken by sound vibrations, however near the lightning. Now water is some 800 times denser than is the air, and therefore the amplitude of the forced vibrations imposed upon raindrops by the thunder-shaken atmosphere must be excessively small, so that but little jostling together of the drops can result from even the loudest thunder. Besides, it is far from certain that those drops that are forced to collide commonly coalesce. It is known, for instance, that two streams of water on striking together at a small angle will, when unelectrified, rebound

[1] Physikalische Zeitschrift 10, 965, 1909.

[2] Meteorologische Optik.

from each other, and it would appear that the same must be true of water drops.

Presumably, then, mere sound vibrations, even of the magnitude of those due to lightning, can have but little effect on the coalescence and consequent growth and size of raindrops. True an increase, both in the size of the drops and in the intensity of the rain, often follows vivid flashes of lightning; but this need not, and, as we have just seen, scarcely can be, attributed to the coalescence of smaller drops through the action of the thunder's vibrations. To the writer it seems far more probable that the conditions that lead to a lightning discharge also lead, commonly, to the production of large drops through rapid condensation, and, owing to convection, long suspension. Besides these conditions, favorable to the formation of large drops during thunderstorms, there probably exist, in portions of the cloud, those potential gradients, which, as has been demonstrated in the laboratory, favor the coalescence of all drops that for any reason chance to collide.

If the above ideas are approximately correct we may consider the formation of large raindrops and of loud peals of thunder as more or less concurrent phenomena, rather than as phenomena that are appreciably related to each other in the sense of cause and effect.

Since the large drops and the lightning flashes often originate at about the same time and place, therefore the latter, because it travels fastest, is first to reach the observer; the thunder is next; while the big drops, moving still slower than sound, are the last of all.

Therefore the phenomena observed by Mr. Laine may be explained as due to large drops that were already formed above the rainbows at the time of the lightning discharge. The lightning flash was seen the instant, almost, that it was formed, while the sound reached the observer at about that time when the large drops had fallen down to the level of the bows.

Mr. Laine's observations are very interesting, and furnish excellent observational support to the theory of the rainbow, but it does not appear that they definitely prove the efficacy of sound to facilitate rain.

(IV) UPPER AIR DATA FOR OCTOBER, NOVEMBER, AND DECEMBER, 1909.

By the Aerial Section; W. R. BLAIR in charge.

Upper air observations were made on 89 of the 92 days in this period, there being three days in December, the 13th, 26th, and 27th, on which observations could not be made. An "ice" storm on the 13th, high wind on the 26th, and very light wind on the 27th account for the failure to get kites up on these days. Of the 89 observations made, 11 were by means of captive balloons and 78 by means of kites.

The mean of the highest altitudes reached in the balloon ascensions is 2138 meters, the highest ascension, October 6, being 3084 meters above sea level. A similar mean for the 78 kite flights is 3342 meters, the highest flight, November 6, being 5929 meters above sea level. The mean of the 24 kite fights made in October is 3486 meters; of the 27 made in November, 3408; and of the 27 made in December, 2777. This October mean is the best attained by us for any month. The mean for the quarter is also a highest record.

Northwest winds prevailed decidedly during the period, southeast being about one-third as frequent. The mean wind velocity for October was 23.1 kilometers per hour; for December, 31.8; and for the period, 27.2. The amplitude and abruptness of the barometric changes increase during the period well in keeping with the increasing wind velocity. The surface temperatures for the mountain and valley are shown in figs. 48, 49, and 50, and the cloud observations at Mount Weather for the three months are as follows.

Month.	Number of days.			Mean cloudiness.
	Clear.	Partly cloudy.	Cloudy.	
October	15	12	4	3.7
November	13	11	6	4.3
December	13	11	7	4.5

The mean temperatures at the various stations for this year are 2.5° lower in October, 2.3° higher in November, and 3.0° lower in December, than those of last year for these three months. The mean daily range in temperature is about the same this year as last in October and November, but greater in December. This December was decidedly clearer than last, though the winds were somewhat higher. The October range is slightly greater than that of either August or September of this

year. The latter months were somewhat cloudier and the wind velocity not enough less to have much effect, though in November and December, with cloudiness about the same as in August and September, the increased wind velocity is accompanied by a considerably reduced daily range of temperature. The December range is about two-thirds that of September. These months have about the same cloudiness, but the December wind velocity is nearly twice as high as that of September. Lower temperature and decreased insolation in December are also factors in its decreased daily range of temperature.

At a glance over the isothermal charts for the three months, one sees the increasing abruptness in the rise and fall of the isotherms, also the increasing number of inversions of temperature from October to December. These features are characteristic of the charts for the period, and indicate that, accompanying the above-mentioned changes in the character of the barogram and in horizontal wind velocity during these, three months, there is an increasing vertical air movement.

The flights of October 16, 22, 28, November 4, and 18 are of peculiar interest, especially those of October 28 and November 18. These flights were made in the extreme rear of an area of low pressure and in front of a high pressure area which advanced directly on the station. The conditions were better defined on the two last-named dates and the flights were higher than are usually obtained at such times. The west to northwest winds which prevail at Mount Weather because of this pressure distribution are usually of too high velocity for satisfactory kite flying. The temperature gradient in all the flights mentioned was approximately 1° C. per 100 meters as far up as the soundings were made. These data seem to justify for the most part interpolations made in previous isothermal charts on similar occasions, and to support the conclusion stated at the top of page 156, in this volume of the Bulletin. The data obtained on December 8, 9, and 10 are also interesting in this connection. The surface air pressure rose more rapidly on the 10th than on the 7th, 8th, and 9th.

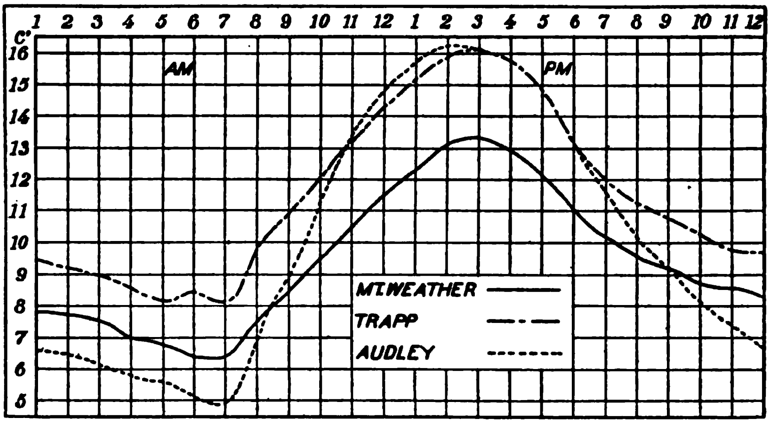


FIG. 48.—Mean hourly temperatures, October, 1909.

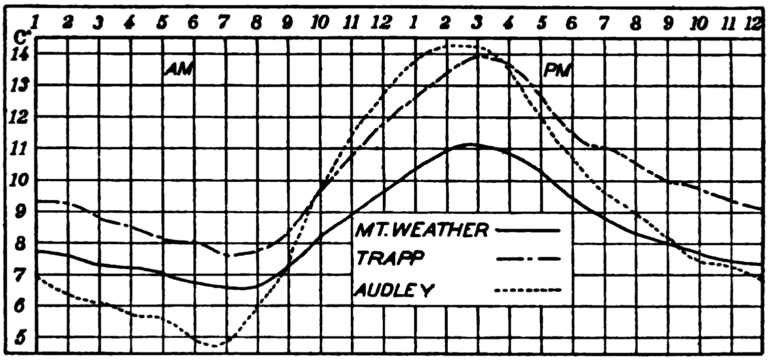


FIG. 49.—Mean hourly temperatures, November, 1909.

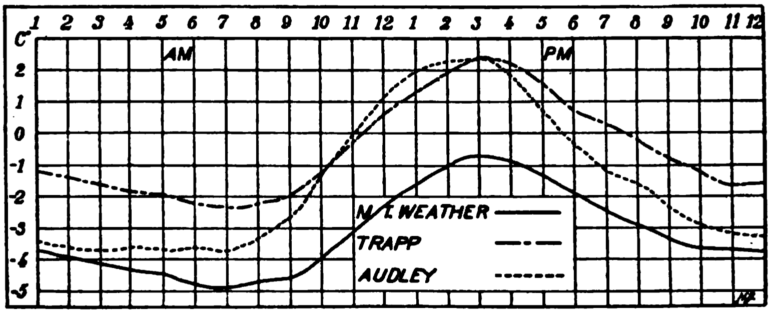


FIG. 50.—Mean hourly temperatures, December, 1909.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909.											
Oct. 1.	*mm.*	° *C.*	%		*m. p. s.*	*Meters.*	*mm.*	° *C.*	%		*m. p. s.*
7:17 a. m.	715.0	9.6	67	wnw.	4.9	526	715.0	9.6	67	wnw.	4.9
7:33 a. m.	715.0	10.0	66	wnw.	5.4	1102	666.9	5.4	......	wnw.	....
7:54 a. m.	715.0	10.7	70	wnw.	5.4	1583	620.7	0.1	......	wnw.	....
8:00 a. m.	715.0	10.3	77	wnw.	5.4	1757	615.1	6.1	......	wnw.	....
8:08 a. m.	715.0	10.2	79	wnw.	5.4	1905	604.0	5.2	......	wnw.	....
8:21 a. m.	715.0	10.8	67	wnw.	5.8	2170	584.8	3.3	......	wnw.	....
8:42 a. m.	715.0	11.2	65	wnw.	7.2	2606	554.2	2.5	......	sw.	....
8:47 a. m.	715.0	11.4	63	wnw.	8.9	2999	528.0	3.5	......	sw.	....
9:13 a. m.	715.0	11.8	62	wnw.	8.5	2867	537.4	4.7	......	sw.	....
10:05 a. m.	715.0	12.8	57	wnw.	11.2	2618	554.2	3.3	......	w.	....
10:32 a. m.	715.0	13.4	57	wnw.	8.9	2288	577.4	4.4	......	wnw.	....
10:53 a. m.	715.0	13.8	57	wnw.	11.2	1970	600.3	4.4	......	wnw.	....
11:13 a. m.	715.0	13.8	51	wnw.	9.8	1673	622.5	6.0	......	wnw.	....
11:27 a. m.	715.0	14.8	53	wnw.	8.9	1410	642.9	4.2	......	w.	....
11:37 a. m.	715.0	14.3	52	wnw.	7.6	1086	668.7	7.5	......	wnw.	....
11:45 a. m.	715.0	14.6	50	wnw.	7.6	838	689.0	10.2	......	wnw.	....
11:52 a. m.	715.0	14.4	52	wnw.	5.8	526	715.0	14.4	52	wnw.	5.8
Oct. 2.											
7:04 a. m.	715.6	6.8	72	wnw.	6.7	526	715.6	6.8	72	wnw.	6.8
7:18 a. m.	715.7	7.8	70	wnw.	6.7	969	678.3	5.9	......	nw.	....
7:30 a. m.	715.8	7.8	70	wnw.	7.2	1425	641.4	3.0	......	nw.	....
7:41 a. m.	715.9	8.4	71	wnw.	6.7	1931	602.6	0.9	......	nw.	....
7:53 a. m.	716.0	8.5	72	wnw.	6.3	2415	567.7	1.5	......	nw.	....
8:08 a. m.	716.0	8.6	72	wnw.	7.2	2822	539.7	1.1	......	nw.	....
9:40 a. m.	716.0	11.4	56	wnw.	7.6	3668	486.1	− 2.5	......	wnw.	....
10:21 a. m.	716.0	12.4	52	wnw.	11.6	3131	520.0	0.1	......	wnw.	....
10:53 a. m.	716.0	11.8	54	nw.	11.6	2525	560.3	3.0	......	wnw.	....
11:28 a. m.	716.0	12.4	52	nw.	11.6	1891	606.3	− 0.5	......	wnw.	....
11:55 a. m.	715.9	12.4	54	nw.	11.2	1567	630.8	1.3	......	wnw.	....
12:16 p. m.	715.8	13.2	51	nw	13.4	1018	674.8	7.0	......	wnw.	....
12:33 p. m.	715.6	13.1	50	nw.	13.4	526	715.6	13.1	50	nw.	13.1

October 1.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 4435 m. at maximum altitude.

There were about 4/10 St.-Cu. from the west at 7:17 a. m. They increased to 6/10 at 8 a. m. and then diminished to 2/10 by the end of the flight.

Areas of low pressure were central over Quebec and southern Florida. An area of high pressure was central over northern Illinois.

October 2.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 7000 m.; at maximum altitude, 6000 m.

The sky was cloudless at 7:04 a. m. At 9:40 a. m. there were 2/10 St.-Cu. from the west-northwest, altitude, 3600 m. These increased to 9/10 from the northwest, altitude 2200 m., at 10:38 a. m. They decreased to 4/10 by the end of the flight.

A ridge of high pressure extended from the upper Lakes to the Gulf. Pressure was low over the St. Lawrence Valley and southern Florida.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Oct. 3.	*mm.*	*° C.*	*%*		*m. p. s.*	*Meters.*	*mm.*	*° C.*	*%*		*m. p. s.*
7:08 a. m....	717.7	6.8	86	wnw.	7.2	526	717.7	6.8	86	wnw.	7.2
7:20 a. m....	717.9	6.8	87	wnw.	6.3	937	683.0	7.2	......	nw.	....
7:30 a. m....	718.0	6.9	86	wnw.	3.5	1320	651.8	3.5	......	nnw.	....
7:45 a. m....	718.1	7.4	82	nw.	6.3	1624	628.2	8.6	......	wnw.	....
8:02 a. m....	718.2	7.7	81	nw.	6.3	2219	584.5	4.7	......	nw.	....
8:35 a. m....	718.2	8.8	78	nw.	6.3	2793	544.5	0.8	......	nw.	....
9:29 a. m....	718.2	10.5	75	nw.	8.0	3175	519.2	− 1.7	......	nw.	....
10:35 a. m....	718.1	11.9	68	nw.	8.9	2376	573.3	3.3	......	nw.	....
10:57 a. m....	718.1	11.8	70	nw.	8.9	1514	637.0	7.3	......	nw.	....
11:14 a. m....	718.1	12.0	67	nw.	8.9	1256	657.3	4.3	......	nw.	....
11:25 a. m....	718.1	12.5	65	nw.	8.0	853	690.5	7.7	......	nw.	....
11:34 a. m....	718.0	12.6	63	wnw.	8.0	526	718.0	12.6	63	wnw.	8.0

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Oct. 4.											
10:00 a. m....	721.4	11.1	77	w.	1.8	526	721.4	11.1	77	w.	1.8
10:15 a. m....	721.4	11.0	78	nw.	1.8	2233	585.7	4.6	......	nw.	....
10:22 a. m....	721.5	11.0	78	nw.	1.8	1752	621.5	2.0	......	nw.	....
10:38 a. m....	721.5	11.1	78	nw.	1.8	1556	636.8	3.5	......	wnw.	....
10:57 a. m....	721.6	11.4	78	nw.	1.8	1470	643.7	5.1	......	calm.	....
11:09 a. m....	721.6	11.9	75	nw.	1.8	1012	680.6	7.1	......	calm.	....
11:18 a. m....	721.6	11.9	73	nw.	1.8	526	721.6	11.9	73	nw.	1.8
Oct. 5.											
1:27 p. m....	724.2	15.8	65	se.	3.1	526	724.2	15.8	65	se.	3.1
1:45 p. m....	724.1	16.2	59	s.	3.1	2500	571.3	7.8	......	ssw.	....
2:00 p. m....	724.0	17.3	59	s.	3.6	1999	607.2	5.7	......	ssw.	....
2:13 p. m....	724.0	16.6	61	s.	2.2	1606	636.8	8.7	......	calm.	....
2:24 p. m....	723.9	16.6	62	s.	2.2	1065	679.2	10.9	......	sse.	....
2:37 p. m....	723.9	17.0	60	se.	2.2	526	723.9	17.0	60	se.	2.2

October 3.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5000 m.; at maximum altitude, 4250 m.

St.-Cu., from the northwest, increased from 1/10 at the beginning to 8/10 at 10 a. m., and decreased to 6/10 by the end of the flight. The head kite was hidden by St.-Cu. from 9:25 until about 10:45 a. m.; altitude of cloud base was about 1600 m.

Pressure was high over the Lake region, the Atlantic States, and the Gulf States, and was relatively low over the Missouri Valley.

October 4.—One balloon was used; capacity, 31.1 cu. m. Wire out, 2400 m.

About 9/10 St.-Cu. from the northwest were observed. The balloon was in St.-Cu. at altitudes greater than 850 m. in ascent, and 700 m. in descent.

An area of relatively low pressure was central over Cuba. An extensive area of high pressure was central over the upper Lakes.

October 5.—One balloon was used; capacity, 31.1 cu. m. Wire out, 2000 m.

About 5/10 Cu. from the southeast were observed.

High pressure, central over Lake Huron, covered the United States east of the Rocky Mountains.

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909. Oct. 6.	*mm.*	° *C.*	%		*m. p. s.*	*Meters.*	*mm.*	° *C.*	%		*m. p. s.*
3:01 p. m....	722.4	18.7	54	sse.	1.8	526	722.4	18.7	54	sse.	1.8
3:10 p. m....	722.3	19.0	53	sse.	1.8	1520	642.5	10.8	......	calm.	....
3:33 p. m....	722.1	19.8	52	s.	1.3	3084	531.4	4.8	......	ne.	....
3:40 p. m....	722.1	20.0	52	se.	1.3	2802	550.1	5.8	......	nne.	....
3:59 p. m....	721.9	19.4	54	se.	1.3	2084	590.9	8.7	......	nne.	....
4:11 p. m....	721.9	18.8	55	se.	1.3	1832	618.4	7.8	......	nnw.	....
4:20 p. m....	721.9	20.0	53	se.	1.3	1441	648.0	9.7	......	w.	....
4:31 p. m....	721.8	20.0	53	s.	1.3	1000	683.0	15.3	......	calm.	....
4:39 p. m....	721.8	20.2	52	s.	1.3	526	721.8	20.2	52	s.	1.3
Oct. 7.											
2:22 p. m....	719.0	21.1	39	n.	2.7	526	719.0	21.1	39	n.	2.7
2:30 p. m....	719.0	21.1	40	n.	2.7	1469	643.9	12.5	......	n.	....
2:50 p. m....	718.8	20.8	45	ne.	2.4	2956	538.5	4.4	......	nne.	....
3:01 p. m....	718.8	21.1	40	ne.	1.8	2181	591.5	8.5	......	nne.	....
3:16 p. m....	718.8	21.0	43	ne.	1.8	1889	612.5	10.1	......	nne.	....
3:39 p. m....	718.8	20.8	35	n.	1.3	1761	621.7	10.5	......	n.	....
3:52 p. m....	718.8	21.4	40	n.	1.2	1490	642.1	11.6	......	n.	....
4:01 p. m....	718.8	20.5	44	n.	1.5	1064	675.2	16.1	......	ne.	....
4:13 p. m....	718.8	20.4	42	n.	1.5	526	718.8	20.4	42	n.	1.5
Oct. 8.											
1:37 p. m....	720.7	21.0	39	nne.	2.7	526	720.7	21.0	39	nne.	2.7
1:52 p. m....	720.6	21.8	41	nnw.	1.8	2222	590.6	12.3	......	e.	....
2:04 p. m....	720.6	21.4	39	n.	2.2	1550	639.3	12.7	......	e.	....
2:25 p. m....	720.6	22.4	38	n.	1.8	1382	652.2	13.4	......	e.	....
2:33 p. m....	720.6	22.2	41	nnw.	1.8	1006	681.7	16.9	......	e.	....
2:44 p. m....	720.6	21.2	39	nne.	1.8	526	720.6	21.2	39	nne.	1.8
Oct. 9.											
7:37 a. m....	723.1	17.6	53	e.	0.9	526	723.1	17.6	53	e.	0.9
7:56 a. m....	723.2	18.0	49	e.	1.8	2406	579.1	10.1	......	ene.	....
8:11 a. m....	723.2	18.5	53	e.	1.8	1932	613.0	11.9	......	e.	....
8:28 a. m....	723.3	18.7	52	e.	1.0	1291	661.2	13.5	......	ese.	....
8:40 a. m....	723.4	19.3	52	e.	1.0	970	686.9	16.0	......	ese.	....
8:54 a. m....	723.5	20.0	55	e.	1.0	526	723.5	20.0	55	e.	1.0
Oct. 10.											
8:31 a. m....	722.0	16.2	73	ese.	2.2	526	722.0	16.2	73	ese.	2.2
8:46 a. m....	721.9	15.8	76	ese.	2.2	2094	599.9	12.8	......	s.	....
9:09 a. m....	721.8	15.6	77	ese.	2.7	1529	641.2	13.0	......	sse.	....
9:26 a. m....	721.7	15.4	80	se.	3.1	850	694.7	14.9	......	sse.	....
9:36 a. m....	721.6	14.6	81	ese.	3.1	526	721.6	14.6	81	ese.	3.1

October 6.—Two balloons were used; capacity, 56.7 cu. m. Wire out, 3160 m.

Few St.-Cu. from the west, after 4 p. m. from the southwest, were observed. The balloon was in the St.-Cu. at an altitude of 2700 m.

Pressure was relatively low over the Gulf of St. Lawrence. An extensive area of high pressure was central over the lower Lakes.

October 7.—Two balloons were used; capacity, 56.7 cu. m. Wire out, 3500 m.

The sky was cloudless.

High pressure, central over West Virginia, covered the United States east of the Mississippi.

October 8.—One balloon was used; capacity, 31.1 cu. m. Wire out, 2300 m.

The sky was cloudless. Light haze prevailed.

High pressure, central over West Virginia, covered the eastern United States.

October 9.—One balloon was used; capacity, 31.1 cu. m. Wire out, 2200 m.

The sky was cloudless.

High pressure, central over New York, covered the eastern half of the United States. Low pressure was central over Missouri.

October 10.—One balloon was used; capacity, 31.1 cu. m. Wire out, 1900 m.

Ci.-St. from the west increased from few at the beginning to 2/10 at the end of the ascension.

Low pressure was central over Iowa. Pressure was high from the Carolinas northward.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.											
Oct. 11.	*mm.*	*° C.*	%		*m. p. s.*	*Meters.*	*mm.*	*° C.*	%		*m. p. s.*
1:20 p. m....	707.6	16.0	100	se.	6.7	526	707.6	16.0	100	se.	6.7
1:28 p. m....	707.6	16.1	100	se.	5.8	955	672.5	12.9	......	s.	....
1:39 p. m....	707.5	16.2	100	se.	6.3	1382	639.1	8.7	......	s.	....
2:18 p. m....	707.1	16.2	100	se.	7.2	1572	624.3	8.1	......	s.	....
3:00 p. m....	706.6	15.3	99	se.	7.2	1177	653.9	10.3	......	s.	....
3:20 p. m....	706.3	15.2	96	se.	6.3	918	674.3	12.5	......	s.	....
3:33 p. m....	706.1	15.2	96	se.	7.2	526	706.1	15.2	96	se.	7.2
Oct. 12.											
7:33 a. m....	708.6	9.0	69	w.	9.4	526	708.6	9.0	69	w.	9.4
7:38 a. m....	708.7	9.0	67	w.	8.9	928	675.1	7.8	......	w.	....
8:02 a. m....	708.8	9.6	64	w.	8.0	1226	651.0	5.0	......	wsw.	....
8:21 a. m....	708.9	10.8	58	w.	5.8	1910	598.6	− 0.1	......	sw.	....
10:03 a. m....	709.2	10.3	64	w.	8.5	3071	518.4	− 4.0	......	sw.	....
11:31 a. m....	709.2	11.0	54	w.	8.0	2111	583.7	− 3.1	......	sw.	....
11:50 a. m....	709.2	11.3	56	w.	8.5	911	677.0	6.9	......	sw.	....
12:07 p. m....	709.2	11.2	67	w.	7.2	526	709.2	11.2	67	w.	7.2
Oct. 13.											
9:49 a. m....	714.3	3.4	38	wnw.	6.3	526	714.3	3.4	38	wnw.	6.3
10:07 a. m....	714.3	3.6	41	wnw.	5.8	957	677.0	− 1.4	......	w.	....
12:10 p. m....	713.5	6.2	32	wnw.	8.0	1751	612.2	− 7.5	......	w.	....
12:15 p. m....	713.4	6.2	32	wnw.	8.0	1973	595.0	− 4.5	......	w.	....
12:28 p. m....	713.3	6.5	30	wnw.	8.9	2656	545.7	− 7.5	......	w.	....
12:58 p. m....	713.0	6.6	31	wnw.	8.9	3597	482.8	−10.6	......	wsw.	....
1:02 p. m....	713.0	6.8	31	wnw.	8.9	3797	470.2	− 9.3	......	wsw.	....
1:16 p. m....	712.9	7.1	27	wnw.	10.7	4460	430.9	−12.5	......	wsw.	....
2:00 p. m....	712.6	7.3	27	wnw.	10.7	3828	468.3	−10.7	......	w.	....
2:08 p. m....	712.6	7.5	27	wnw.	8.9	3734	474.0	−13.4	......	w.	....
3:24 p. m....	712.6	7.4	28	wnw.	9.8	2864	530.7	− 9.3	......	w.	....
3:30 p. m....	712.6	7.4	28	wnw.	12.1	2568	551.3	− 5.9	......	w.	....
4:22 p. m....	712.6	6.5	27	wnw.	12.5	1970	595.0	− 7.2	......	w.	....
4:54 p. m....	712.8	5.8	32	wnw.	8.0	1394	640.0	− 3.0	......	w.	....
5:11 p. m....	712.9	5.2	33	wnw.	8.0	925	678.7	0.7	......	wnw.	....
5:21 p. m....	713.0	5.0	36	wnw.	7.2	526	713.0	5.0	36	wnw.	3.6

October 11.—One kite was used; lifting surface, 6.3 sq. m. Wire out, 3000 m.; at maximum altitude, 2700 m.

Dense fog prevailed until 2:32 p. m. and from 2:36 to 2:52 p. m. From 4/10 to 10/10 St. from the southeast were visible after 2:52 p. m., and about 5/10 St. from the south after 2:57 p. m. Light rain fell until 2:52 p. m. The kite was visible for short intervals at 2:47 and 3:02 and continuously after 3:17 p. m.

High pressure was central over New Brunswick, and low pressure over Lake Superior and western Cuba.

October 12.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 6400 m.; at maximum altitude, 5300 m.

About 8/10 St.-Cu. from the southwest were present at the beginning of the flight These decreased to 3/10 by 10:05 a. m. and then increased to 8/10 by the end of the flight.

Low pressure was central over Upper Michigan, and high pressure over Oklahoma.

October 13.—Four kites were used; lifting surface, 35.2 sq. m. Wire out, 6250 m.; at maximum altitude, 6000 m.

A few Cu. were present until 2:30 p. m. A few Ci. were visible on the southwest horizon from 11:54 a. m. to 2:30 p. m. The sky was cloudless thereafter.

Low pressure was central north of Lake Superior, and pressure was high over Alabama.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Oct. 14.	*mm.*	°C.	%		*m. p. s.*	*Meters.*	*mm.*	°C.	%		*m. p. s.*
7:34 a. m....	713.1	3.3	87	s.	5.4	526	713.1	3.3	87	s.	5.4
7:46 a. m....	713.1	3.4	90	s.	5.8	954	676.6	3.3	......	sw.	....
7:55 a. m....	713.1	3.0	93	s.	4.9	1449	636.3	0.6	......	sw.	....
8:16 a. m....	713.0	3.6	88	s.	7.2	2041	590.8	− 2.7	......	sw.	....
8:32 a. m....	712.8	3.7	91	s.	5.8	2676	545.3	− 5.2	......	wsw.	....
8:57 a. m....	712.6	4.5	88	s.	4.9	3244	506.8	− 7.4	......	wsw.	....
9:15 a. m....	712.5	4.6	89	s.	4.5	3785	471.7	−12.2	......	wsw.	....
9:32 a. m....	712.3	6.2	81	s.	3.6	4182	449.0	−10.2	......	wsw.	....
11:05 a. m....	711.6	7.6	75	s.	7.2	4673	422.9	−14.8	......	wsw.	....
11:53 a. m....	710.6	8.3	68	s.	6.7	3936	464.1	−10.4	......	wsw.	....
12:35 p. m....	710.0	8.6	65	s.	5.4	3223	508.7	− 6.2	......	wsw.	....
1:25 p. m....	709.4	9.6	64	s.	7.6	2098	585.3	0.8	......	sw.	....
1:45 p. m....	709.2	9.7	64	s.	6.3	1464	632.6	5.8	......	sw.	....
2:02 p. m....	709.1	9.4	65	s.	5.4	938	674.8	4.5	......	s.	....
2:10 p. m....	709.0	9.8	72	s.	5.4	526	709.0	9.8	72	s.	5.4
Oct. 15.											
7:17 a. m....	708.6	4.2	50	nw.	9.8	526	708.6	4.2	50	nw.	9.8
7:25 a. m....	708.7	4.2	53	nw.	10.7	995	668.8	1.6	......	nw.	....
7:43 a. m....	708.8	4.6	51	wnw..	6.7	1866	600.4	− 0.8	......	wnw.	....
7:57 a. m....	709.1	4.8	51	wnw.	7.2	2237	573.7	− 0.8	......	wnw.	....
8:33 a. m....	709.2	5.4	49	wnw.	8.0	2730	539.3	− 3.2	......	wnw.	....
9:00 a. m....	709.2	6.0	47	nw.	7.2	3455	491.4	− 8.1	......	wnw.	....
9:32 a. m....	709.2	6.7	46	wnw.	8.9	4416	433.9	−13.3	......	w.	....
10:11 a. m....	709.2	7.6	47	nw.	8.0	5178	392.3	−18.3	......	w.	....
12:33 p. m....	708.6	10.2	42	nw.	9.8	5912	356.1	−23.0	......	w.	....
1:25 p. m....	708.4	10.1	42	wnw.	9.4	5214	390.4	−20.0	......	w.	....
2:00 p. m....	708.5	9.5	42	w.	9.8	4287	441.5	−14.0	......	w.	....
2:27 p. m....	708.5	9.6	45	w.	10.3	3241	504.5	− 6.2	......	w.	....
2:38 p. m....	708.6	9.5	44	nw.	7.6	2446	558.0	− 2.8	......	w.	....
2:45 p. m....	708.6	10.0	42	nw.	8.5	2291	569.2	− 6.0	......	w.	....
2:53 p. m....	708.6	10.4	41	nw.	7.2	1848	602.2	− 3.0	......	w.	....
3:14 p. m....	708.6	9.2	44	wnw.	8.5	979	670.6	5.0	......	w.	....
3:18 p. m....	708.6	9.4	42	wnw.	8.5	526	708.6	9.4	42	wnw.	8.5

October 14.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 10000 m.; at maximum altitude, 7700 m.

St.-Cu. from the southwest at an altitude of about 2300 m. covered the sky until about 11 a. m., rapidly diminishing thereafter. At a higher altitude were from 6/10 to 8/10 Ci. from the west-southwest. Light rain fell from 7:10 to 8:44 a. m. A solar halo was observed.

A well-developed low was central north of Lake Superior and a moderate high over Florida.

October 15.—Eight kites were used; lifting surface, 50.4 sq. m. Wire out, 13400 m.; at maximum altitude, 11000 m.

St.-Cu., from the west, increased from few before 11 a. m. to 9/10 at 2:30 p. m., and diminished to 7/10 by 3 p. m. The head kite was hidden by St.-Cu. at intervals from 1:10 to 2:47 p. m., when it descended through the St.-Cu. base at an altitude of 2200 m.

Low pressure, central north of the upper Lakes, covered the eastern United States, except the Gulf States.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.											
Oct. 16.	*mm.*	° *C.*	%		*m. p. s.*	*Meters.*	*mm.*	° *C.*	%		*m. p. s.*
8:51 a. m....	713.3	4.6	56	nw.	11.6	526	713.3	4.6	56	nw.	11.6
9:00 a. m....	713.4	5.0	58	nw.	10.7	883	682.7	1.0	......	nw.	....
9:27 a. m....	713.6	5.2	59	nw.	11.6	1397	640.3	− 3.5	......	nw.	....
10:01 a. m....	713.8	5.8	57	wnw.	9.8	1725	614.5	− 6.5	......	wnw.	....
10:26 a. m....	713.9	7.0	50	wnw.	10.3	2305	571.1	− 9.8	......	nw.	....
10:55 a. m....	714.0	6.7	44	wnw.	12.1	2610	549.8	−12.0	......	nw.	....
11:05 a. m....	714.0	6.9	45	nw.	14.8	2679	544.2	− 9.0	......	nw.	....
11:09 a. m....	714.1	7.0	45	nw.	15.2	2814	534.9	−12.0	......	nw.	....
11:16 a. m....	714.1	7.2	45	nw.	14.3	2653	546.1	− 9.0	......	nw.	....
11:35 a. m....	714.2	7.4	44	nw.	12.1	2607	549.8	−11.5	......	nw.	....
12:13 p. m....	714.4	7.4	44	nw.	16.1	2011	593.5	− 8.0	......	nw.	....
12:45 p. m....	714.6	7.4	50	nw.	11.6	1742	614.5	− 5.6	......	nw.	....
1:13 p. m....	714.7	6.8	45	nw.	15.2	1322	647.7	− 2.0	......	nw.	....
1:40 p. m....	714.9	7.0	45	nw.	16.1	881	684.6	2.9	......	nw.	....
1:59 p. m....	715.0	8.4	38	wnw.	14.3	526	715.0	8.4	38	wnw.	14.3
Oct. 17.											
7:28 a. m....	721.7	4.4	55	w.	7.2	526	721.7	4.4	55	w.	7.2
7:37 a. m....	721.7	4.8	54	w.	7.2	1085	674.0	1.1	......	wnw.	....
7:52 a. m....	721.9	5.0	53	wnw.	6.3	1534	637.0	− 2.8	......	wnw.	....
8:01 a. m.....	721.9	5.2	54	wnw.	7.2	1740	620.4	− 5.1	......	wnw.	....
8:09 a. m....	721.9	5.3	54	wnw.	7.2	2030	598.2	− 0.5	......	wnw.	....
8:29 a. m....	722.1	5.3	54	wnw.	7.2	2539	561.4	− 2.3	......	wnw.	....
8:37 a. m....	722.2	5.5	55	wnw.	7.2	2755	546.4	− 3.1	......	wnw.	....
8:53 a. m....	722.4	5.8	52	wnw.	7.2	3034	527.7	− 2.5	......	wnw.	....
9:20 a. m....	722.4	6.2	56	wnw.	8.0	2627	555.8	− 2.0	......	wnw.	....
9:46 a. m....	722.5	6.6	50	wnw.	8.5	2228	584.5	0.1	......	wnw.	....
10:13 a. m....	722.5	7.0	49	wnw.	6.3	2042	598.2	− 1.2	......	wnw.	....
10:30 a. m....	722.6	7.3	45	w.	7.2	1779	618.5	− 4.4	......	wnw.	....
10:36 a. m....	722.6	7.3	47	w.	7.2	1293	657.4	− 0.6	......	wnw.	....
10:44 a. m....	722.6	7.6	47	w.	7.2	898	690.5	3.3	......	wnw.	....
10:51 a. m....	722.6	7.6	49	wnw.	7.6	526	722.6	7.6	49	wnw.	7.6
Oct. 18.											
7:30 a. m....	721.6	5.4	67	ese.	7.2	526	721.6	5.4	67	ese.	7.2
7:42 a. m....	721.2	5.1	71	ese.	8.0	863	692.1	5.4	......	sse.	....
7:52 a. m....	721.5	5.2	72	ese.	8.0	1270	658.9	8.4	......	ssw.	....
8:10 a. m....	721.4	4.4	84	se.	6.3	1695	625.6	5.2	......	sw.	....
9:10 a. m....	721.3	6.2	70	se.	4.5	2014	601.6	2.4	......	wsw.	....
9:34 a. m....	721.1	6.5	71	se.	4.5	2630	557.3	1.4	......	wsw.	....
9:43 a. m....	721.0	6.6	74	se.	4.5	526	721.0	6.6	74	se.	4.5

October 16.—Two kites were used; lifting surface, 10.8 sq. m. Wire out, 4200 m., at maximum altitude.

From 1/10 to 7/10 St.-Cu. from the west were observed. The head kite was in the clouds at intervals from 10:30 to 11:58 a. m.

Low pressure was central over the Gulf of St. Lawrence and high pressure over Alabama.

October 17.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 5000 m., at maximum altitude.

Ci.-Cu. from the northwest, increased from few at the beginning to 6/10 at the close of the flight.

Pressure was high over the Carolinas and low over the Gulf of St. Lawrence.

October 18.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 4000 m., at maximum altitude.

At the beginning 5/10 A.-St. and 5/10 St. from the west-southwest were present. The lower clouds gradually increased and after 8:06 a. m. covered the sky. Light rain fell from 7:51 to 8:48 a. m., and from 9:38 a. m. to the end of the flight.

High pressure was central off the South Carolina coast. Pressure was relatively low over southwestern Pennsylvania.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Oct. 19.	mm.	° C.	%		m. p. s.	Meters.	mm.	° C.	%		m. p. s.
7:21 a. m....	727.2	1.6	83	nnw.	7.6	526	727.2	1.6	83	nnw.	7.6
7:35 a. m....	727.2	1.4	83	nnw.	7.2	905	693.6	− 1.1	......	n.	....
7:43 a. m....	727.2	1.4	83	nnw.	7.6	1229	666.0	− 2.4	......	n.	....
8:07 a. m....	727.3	1.9	82	nw.	8.9	1590	636.8	1.8	......	nnw.	....
8:50 a. m....	727.6	3.0	77	nw.	9.2	2440	572.7	− 4.3	......	nnw.	....
9:01 a. m....	727.6	3.4	75	nw.	9.4	3222	518.6	− 7.9	......	nnw.	....
9:32 a. m....	727.8	3.4	75	nw.	8.5	3338	511.1	− 6.6	......	wnw.	....
10:06 a. m....	728.0	4.7	69	nw.	6.7	4310	451.4	−11.1	......	wnw.	....
10:50 a. m....	727.8	5.7	61	nw.	7.6	4921	417.7	−11.4	......	wnw.	....
2:06 p. m....	727.0	8.7	49	nw.	5.4	4272	455.2	− 9.8	......	wnw.	....
2:37 p. m....	726.6	9.2	51	nw.	5.4	3537	499.8	− 7.1	......	nw.	....
2:55 p. m....	726.4	9.2	46	nnw.	5.8	3161	524.2	− 5.1	......	nw.	....
3:07 p. m....	726.4	9.4	46	nw.	5.4	2848	545.8	− 2.5	......	nnw.	....
4:08 p. m....	726.6	8.9	46	nnw.	5.8	526	726.6	8.9	46	nnw.	5.8
Oct. 20.											
7:23 a. m....	727.7	2.4	71	e.	4.5	526	727.7	2.4	71	e.	4.5
8:54 a. m....	727.7	4.2	69	ese.	4.9	914	693.6	1.7	......	s.	....
10:11 a. m....	727.3	5.3	73	se.	4.9	1262	664.0	0.6	......	ssw.	....
10:43 a. m....	727.2	5.6	73	se.	4.0	1353	656.6	2.0	......	sw.	....
1:23 p. m....	725.6	7.6	72	se.	3.6	1688	628.8	6.7	......	ssw.	....
1:32 p. m....	725.5	8.0	65	se.	3.6	1228	665.8	2.9	......	ssw.	....
1:52 p. m....	725.4	9.2	62	se.	5.4	788	702.7	4.9	......	s.	....
1:56 p. m....	725.3	9.4	61	sse.	5.4	526	725.3	9.4	61	sse.	5.4
Oct. 21.											
7:17 a. m....	720.7	4.6	89	s.	6.7	526	720.7	4.6	89	s.	6.7
7:24 a. m....	720.7	4.7	90	sse.	6.3	954	684.4	12.1	......	ssw.	....
7:41 a. m....	720.6	4.8	90	s.	6.7	1440	645.7	11.5	......	sw.	....
8:04 a. m....	720.6	5.2	86	s.	6.7	2058	599.5	6.3	......	wsw.	....
8:15 a. m....	720.5	5.4	86	s.	7.2	2548	564.6	2.8	......	wsw.	....
8:31 a. m....	720.3	5.6	84	s.	7.2	3097	527.2	− 1.5	......	sw.	....
8:53 a. m....	720.0	6.5	77	s.	6.7	3650	492.3	− 3.2	......	sw.	....
9:33 a. m....	719.9	6.8	79	s.	6.3	4306	453.4	− 6.5	......	sw.	....
10:32 a. m....	719.7	8.7	74	s.	5.4	3678	490.5	− 3.0	......	sw.	....
11:01 a. m....	719.5	8.0	87	s.	4.9	2926	538.4	0.9	......	sw.	....
11:09 a. m....	719.5	7.9	87	s.	4.9	526	719.5	7.9	87	s.	4.9

October 19.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 10000 m., at maximum altitude.

There were from 3/10 to a few Ci.-Cu. from the west-northwest until 8:46 a. m., and from 10:36 a. m. until the close of the flight. From 1/10 to a few Cu. from the north-northwest were observed from 8:46 a. m. until 12:14 p. m.

An area of high pressure was central over the upper Lake region. A low was central southwest of Jamaica.

October 20.—Five kites were used, lifting surface, 32 sq. m. Wire out, 3320 m., at maximum altitude, 2200 m.

The clouds, about 1/10 Ci.-St. from the west at the beginning of the flight, had increased to 8/10 by 11:36 a. m. A few low St. from the southeast passed over the station at 9:02 a. m.

High pressure central over eastern Pennsylvania covered the eastern half of the country.

October 21.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 7000 m.; at maximum altitude, 6800 m.

The sky was covered with A.-St. and St.-Cu. from the southwest at an altitude of about 4000 m. until 10:30 a. m., and with very low St. from the southwest thereafter. Light rain fell from 9:20 to 10:18 a. m., and from 10:35 until after the close of the flight. Pressure was high over the Eastern States and low over Lake Superior.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Oct. 22.	mm.	° C.	%		m. p. s.	Meters.	mm.	° C.	%		m. p. s.
11:12 a. m....	714.9	18.6	29	wnw.	10.7	526	714.9	18.6	29	wnw.	10.7
11:20 a. m....	714.9	18.6	29	w.	12.5	981	677.9	13.4	......	w.	....
11:38 a. m....	714.7	18.6	28	w.	13.9	1263	655.0	8.9	......	w.	....
11:50 a. m....	714.7	18.8	27	w.	15.6	1631	626.3	3.9	......	w.	....
12:38 p. m....	714.4	19.2	26	w.	13.9	1902	606.0	2.4	......	w.	....
1:06 p. m....	714.3	19.4	22	w.	14.3	1453	640.1	7.3	......	w.	....
1:25 p. m....	714.3	19.6	25	w.	12.5	1141	664.5	11.4	......	w.	....
1:39 p. m....	714.3	19.7	26	w.	13.0	526	714.3	19.7	26	w.	13.0
Oct. 23.											
7:32 a. m....	713.7	6.4	92	se.	5.8	526	713.7	6.4	92	se.	5.8
8:11 a. m....	713.5	6.4	92	se.	5.8	917	680.2	4.8	......	sse.	....
8:20 a. m....	713.5	6.4	92	se.	5.8	526	713.5	6.4	92	se.	5.8
Oct. 24.											
9:46 a. m....	713.0	3.1	86	nw.	11.6	526	713.0	3.1	86	nw.	11.6
9:56 a. m....	713.0	3.0	85	nw.	13.9	788	690.1	− 1.1	......	nnw.	....
10:12 a. m....	713.0	3.1	81	nw.	13.0	1082	665.2	− 3.2	......	nnw.	....
10:35 a. m....	713.1	3.1	81	nw.	13.0	1106	663.3	− 0.7	......	nnw.	....
11:40 a. m....	713.2	3.4	83	nw.	12.5	1911	599.1	− 6.1	......	n.	....
11:56 a. m....	713.2	3.5	82	nw.	10.7	1382	640.4	− 1.8	......	n.	....
12:21 p. m....	713.2	3.4	79	nw.	13.0	992	672.9	− 3.4	......	nnw.	....
12:29 p. m....	713.2	3.4	79	nw.	12.1	814	688.2	− 1.3	......	nnw.	....
12:34 p. m....	713.2	3.4	79	nw.	13.0	526	713.2	3.4	79	nw.	13.0
Oct. 25.											
11:15 a. m....	718.1	3.6	56	nw.	9.8	526	718.1	3.6	56	nw.	9.8
11:24 a. m....	718.1	4.5	55	nw.	9.4	820	692.4	− 0.6	......	nw.	....
11:50 a. m....	718.0	4.9	53	wnw.	10.7	979	679.0	7.1	......	nnw.	....
12:12 p. m....	717.8	5.7	52	nw.	8.0	1426	642.7	3.4	......	nnw.	....
12:23 p. m....	717.8	7.2	52	wnw.	7.6	2274	578.8	0.3	......	nw.	....
1:06 p. m....	717.5	6.8	50	nw.	7.2	2807	541.7	− 3.1	......	nw.	....
1:23 p. m....	717.4	7.2	48	nw.	7.6	1941	603.3	1.9	......	nw.	....
1:45 p. m....	717.3	7.6	46	nw.	7.2	998	677.1	7.2	......	nw.	....
2:04 p. m....	717.2	7.8	44	nw.	6.7	861	688.6	4.0	......	nw.	....
2:10 p. m....	717.1	7.6	46	wnw.	6.3	526	717.1	7.6	46	wnw.	6.3

October 22.—Two kites were used; lifting surface, 10.8 sq. m. Wire out, 3600 m.; at maximum altitude, 2500 m.

A few Cu. from the west formed at 11:50 a. m., but soon disappeared.

Low pressure was central over Quebec and high pressure over Georgia.

October 23.—One kite was used; lifting surface, 6.3 sq. m. Wire out, 1140 m.; at maximum altitude, 500 m.

The sky was covered with St. from the west-southwest.

Pressure was low over the Ohio Valley and the Gulf of St. Lawrence and relatively high over Florida.

October 24.—Four kites were used; lifting surface, 21.6 sq. m. Wire out, 4500 m.; at maximum altitude, 3500 m.

The sky was covered with St. from the north-northwest. The head kite was in the clouds except at short intervals from 9:59 a. m. to 12:02 p. m.

Pressure was low off the middle Atlantic coast and high over the Mississippi Valley.

October 25.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 3800 m., at maximum altitude.

The sky was cloudless.

Low pressure was central off the New England coast and high pressure over West Virginia and eastern Tennessee.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Oct. 26.	*mm.*	° *C.*	%		*m. p. s.*	*Meters.*	*mm.*	° *C.*	%		*m. p. s.*
7:25 a. m.	716.8	7.8	40	w.	7.2	526	716.8	7.8	40	w.	7.2
7:36 a. m.	716.9	8.6	38	wsw.	6.7	890	686.1	7.2	......	w.	....
7:47 a. m.	716.9	9.0	33	wsw.	6.7	1308	651.8	3.9	......	w.	....
8:10 a. m.	717.0	9.6	34	wsw.	5.8	1623	627.4	6.9	......	w.	....
8:19 a. m.	717.0	10.0	44	wsw.	5.8	1891	607.3	5.2	......	w.	....
8:50 a. m.	717.1	10.8	30	wsw.	5.8	2709	549.0	− 1.0	......	wsw.	....
9:16 a. m.	717.1	11.6	32	wsw.	5.4	3278	511.1	− 3.7	......	wsw.	....
9:54 a. m.	717.1	12.3	30	wsw.	5.8	3895	472.3	− 9.0	......	w.	....
11:03 a. m.	716.6	13.2	30	wsw.	5.4	4814	418.3	−16.9	......	w.	....
12:10 p. m.	716.1	14.9	27	sw.	5.4	4294	449.0	−11.8	......	wsw.	....
2:01 p. m.	715.2	16.0	28	ssw.	4.0	3444	501.4	− 3.7	......	wsw.	....
2:44 p. m.	715.0	17.7	29	sse.	3.1	2782	545.1	0.9	......	w.	....
3:25 p. m.	714.7	17.2	25	sse.	3.6	2099	592.5	5.9	......	w.	....
3:56 p. m.	714.4	17.3	22	s.	2.7	526	714.4	17.3	22	s.	2.7
Oct. 27.											
7:35 a. m.	714.1	11.7	37	w.	8.0	526	714.1	11.7	37	w.	8.0
7:48 a. m.	714.1	11.8	38	w.	7.6	888	683.8	9.7	......	w.	....
8:03 a. m.	714.2	12.0	38	wsw.	7.6	1339	647.5	5.8	......	w.	....
8:16 a. m.	714.2	12.4	37	wsw.	8.0	1792	612.6	2.2	......	w.	....
8:37 a. m.	714.1	13.0	37	wsw.	7.2	2438	566.1	0.5	......	wsw.	....
8:57 a. m.	714.1	13.4	37	wsw.	6.7	3024	525.1	− 6.3	......	wsw.	....
9:36 a. m.	714.0	14.4	39	wsw.	6.7	3612	487.3	−10.3	......	wsw.	....
10:10 a. m.	714.0	15.0	39	wsw.	5.4	4490	433.5	−19.8	......	w.	....
10:45 a. m.	713.9	15.8	43	wsw.	4.5	5037	402.3	−26.0	......	w.	....
11:15 a. m.	713.9	16.2	43	wsw.	5.4	5282	388.6	−29.3	......	w.	....
12:13 p. m.	713.7	16.3	43	wsw.	5.8	5007	404.2	−25.3	......	w.	....
12:28 p. m.	713.7	16.0	43	wsw.	4.5	4683	423.7	−19.0	......	w.	....
1:19 p. m.	713.2	16.0	43	wsw.	4.5	4399	439.3	−17.8	......	w.	....
2:17 p. m.	712.6	15.8	43	wsw.	5.4	3608	487.3	− 9.8	......	w.	....
2:39 p. m.	712.6	15.6	44	wsw.	4.5	2437	564.1	− 5.3	......	w.	....
3:15 p. m.	712.5	15.2	46	w.	4.9	2045	592.1	− 3.2	......	w.	....
3:40 p. m.	712.5	14.9	48	w.	4.0	1202	657.1	7.0	......	w	....
3:50 p. m.	712.5	14.7	49	w.	4.9	874	683.8	10.9	......	w.	....
3:56 p. m.	712.5	14.6	50	wnw.	5.8	526	712.5	14.6	50	wnw.	5.8

October 26.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 8100 m.; at maximum altitude, 7800 m.

Cloudless until 11:45 a. m. Ci.-St., from southwest until 3 p. m., from west-southwest thereafter, increased to 7/10 by 2 p. m., and diminished to 2/10 by the end of the flight. Solar halo, 2:30 to 3 p. m.

Low pressure was central over Lake Superior and high over South Carolina.

October 27.—Seven kites were used; lifting surface, 44.1 sq. m. Wire out, 12000 m., at maximum altitude.

A few St. near the horizon were visible before 9:46 a. m.; from 3/10 to 9/10 Ci.-Cu., from the west from 9:46 until 11:20 a. m., and from 9/10 to 10/10 Ci.-Cu. and St.-Cu. from the west thereafter. The head kite was in the clouds at intervals from 12:07 to 3:25 p. m.

Low pressure was central over Quebec and high pressure over North Dakota.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.											
Oct. 28.	*mm.*	° *C.*	%		*m. p. s.*	*Meters.*	*mm.*	° *C.*	%		*m. p. s.*
7:27 a. m....	716.1	3.6	65	wnw.	8.0	526	716.1	3.6	65	wnw.	8.0
7:37 a. m....	716.2	3.6	65	wnw.	8.9	924	681.8	0.1	......	nw.	....
7:54 a. m....	716.3	3.8	68	wnw.	8.9	1406	641.7	− 5.1	......	wnw.	....
8:14 a. m....	716.3	4.0	68	wnw.	9.8	1816	608.7	−10.1	......	wnw.	....
8:33 a. m....	716.4	3.8	65	wnw.	8.9	2283	573.1	−13.4	......	wnw.	....
8:58 a. m....	716.5	4.0	66	wnw.	8.9	2749	538.8	−18.2	......	wnw.	....
9:30 a. m....	716.8	2.7	70	wnw.	12.5	1921	600.4	−11.8	......	wnw.	....
9:50 a. m....	716.9	2.4	64	wnw.	9.8	1152	662.7	− 5.5	......	wnw.	....
10:15 a. m....	717.0	2.8	57	wnw.	11.6	862	687.6	− 2.2	......	nw.	....
10:24 a. m....	717.0	3.5	58	wnw.	11.6	526	717.0	3.5	58	wnw.	11.6
Oct. 29.											
7:20 a. m....	720.8	0.5	66	nw.	9.8	526	720.8	0.5	66	nw.	9.8
7:29 a. m....	720.9	0.6	68	wnw.	10.3	913	686.8	− 2.6	......	nw.	....
7:44 a. m....	720.9	1.0	66	nw.	9.8	1303	653.6	− 6.0	......	nw.	....
7:58 a. m....	721.0	1.0	66	nw.	8.9	1690	622.2	− 8.4	......	nw.	....
8:17 a. m....	721.1	1.4	62	nw.	9.8	2233	580.8	− 2.3	......	nw.	....
8:33 a. m....	721.2	1.8	58	wnw.	11.6	2855	537.1	− 3.9	......	nw.	....
9:18 a. m....	721.5	1.8	61	nw	9.4	4077	459.6	− 9.7	......	nnw.	....
12:08 p. m....	720.6	4.9	47	nw.	9.8	2975	529.6	− 4.0	......	nnw.	....
12:22 p. m....	720.4	4.8	47	nw.	11.2	2431	567.0	− 1.5	......	nw.	....
12:50 p. m....	720.2	5.1	45	nw.	11.6	2188	584.5	− 2.0	......	nw.	....
1:22 p. m....	719.7	5.5	43	nw.	8.5	1904	605.6	− 7.4	......	nw.	....
1:59 p. m....	719.0	6.1	39	nw.	11.2	1228	659.2	− 1.4	......	nw.	....
2:12 p. m....	719.0	6.4	39	nw.	10.3	943	683.1	1.4	......	nw.	....
2:22 p. m....	719.0	6.2	36	wnw.	10.7	526	719.0	6.2	36	wnw.	10.7

October 28.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 5000 m., at maximum altitude.

10/10 St.-Cu., moving rapidly from the west-northwest, prevailed until 10:10 a. m., then diminished to 8/10 by the close of the flight. Light snow fell from 9:20 to 10:10 a. m. The head kite entered the clouds at an altitude of about 2000 m., and was coated with ice when it was landed.

A well-developed high was central over Wisconsin and a low over the Gulf of St. Lawrence.

October 29.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 10000 m.; at maximum altitude, 7000 m.

St.-Cu., from the northwest, increased from 5/10 at the beginning to 8/10 at 9 a. m., and diminished to few by 1 p. m. The head kite was hidden by St.-Cu. at intervals from 7:58 to 9:15, and from 10:18 to 10:45 a. m.

High pressure, central over Ohio, covered the United States east of the Mississippi, except New England. Pressure was low over the Gulf of St. Lawrence.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Oct. 30.	mm.	° C.	%		m. p. s.	Meters.	mm.	° C.	%		m. p. s.
7:29 a. m....	722.2	1.2	58	nw.	7.2	526	722.2	1.2	58	nw.	7.2
7:38 a. m....	722.3	1.4	58	nw.	6.7	844	694.3	1.1	......	nw.	....
7:47 a. m....	722.3	1.7	55	nnw.	6.7	1240	661.1	1.8	......	nw.	....
7:51 a. m....	722.5	1.5	55	nw.	6.3	1520	638.9	3.4	......	nnw.	....
8:05 a. m....	722.5	1.4	61	nw.	6.7	2002	601.9	2.0	......	nnw.	....
8:18 a. m....	722.5	1.7	62	wnw.	4.5	2316	579.0	1.0	......	nnw.	....
8:47 a. m....	722.5	3.2	56	wnw.	5.8	3388	506.1	− 4.0	......	nnw.	....
9:17 a. m....	722.5	3.4	56	wnw.	4.5	4019	467.2	− 6.0	......	nnw.	....
10:02 a. m....	722.6	4.0	54	wnw.	4.9	4807	422.2	−11.7	......	nnw.	....
11:00 a. m....	722.4	5.6	52	nw.	6.3	5792	371.0	−16.8	......	nnw.	....
12:07 p. m....	721.6	7.4	37	wnw.	7.6	5084	407.3	−12.5	......	nnw.	....
12:53 p. m....	721.2	8.6	37	wnw.	5.4	4434	443.1	− 8.4	......	nnw.	....
1:40 p. m....	720.6	8.8	32	wnw.	4.0	3997	469.1	− 4.5	......	nnw.	....
2:02 p. m....	720.7	9.6	40	wnw.	2.7	2978	533.4	− 1.0	......	nnw.	....
2:19 p. m....	720.6	10.8	38	wnw.	2.7	2467	568.9	1.5	......	nnw.	....
2:30 p. m....	720.6	11.0	38	wnw.	2.7	1934	607.5	4.0	......	nnw.	....
2:42 p. m....	720.6	11.8	36	wnw.	2.2	1381	650.0	6.7	......	nnw.	....
2:49 p. m....	720.5	11.6	38	w.	1.8	526	720.5	11.6	38	w.	1.8
Oct. 31.											
7:11 a. m....	719.5	11.2	47	w.	7.6	526	719.5	11.2	47	w.	7.6
7:21 a. m....	719.5	12.1	46	w.	8.0	870	690.7	14.0	......	wnw.	....
7:34 a. m....	719.6	13.0	44	wsw.	7.2	1287	657.5	12.0	......	nw.	....
7:51 a. m....	719.7	13.6	41	w.	7.2	1824	616.8	9.2	......	nw.	....
8:22 a. m....	719.7	13.7	41	w.	7.2	2490	569.0	6.2	......	nw.	....
8:43 a. m....	719.8	13.8	42	w.	7.2	3208	521.2	1.0	......	nw.	....
9:01 a. m....	719.8	14.1	40	w.	8.0	3684	491.2	− 1.8	......	nw.	....
9:12 a. m....	719.8	14.3	39	w.	8.9	4114	465.4	− 4.0	......	nw.	....
9:26 a. m....	719.8	14.9	36	w.	8.5	4498	443.2	− 6.6	......	nw.	....
10:24 a. m....	719.8	17.0	31	w.	6.3	3575	498.7	− 1.0	......	wnw.	....
10:43 a. m....	719.9	17.6	28	wnw.	7.2	2886	542.8	3.3	......	w.	....
10:58 a. m....	719.9	17.8	27	w.	8.5	2302	582.8	7.9	......	wnw.	....
11:05 a. m....	719.9	17.6	27	wnw.	8.0	1560	637.2	12.2	......	wnw.	....
11:15 a. m.....	719.8	18.1	26	w.	9.4	1247	661.2	12.0	......	wnw.	....
11:28 a. m....	719.8	18.6	26	wnw.	8.9	857	692.5	14.3	......	wnw.	....
11:37 a. m....	719.8	18.6	27	wnw.	8.9	526	719.8	18.6	27	wnw.	8.9

October 30.—Seven kites were used; lifting surface, 44.1 sq. m. Wire out, 14000 m.; at maximum altitude, 13500 m.

There were from 2/10 to 7/10 St.-Cu. from the northwest. The head kite was in the clouds at intervals from 8:55 a. m. to 2:19 p. m.

Low pressure was central over Nova Scotia and high pressure over Virginia.

October 31.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 8000 m.; at maximum altitude, 7850 m.

There was about 1/10 Ci. from the west.

High pressure was central over North Carolina and low pressure over Kansas.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.											
Nov. 1.	*mm.*	*° C.*	%		*m. p. s.*	*Meters.*	*mm.*	*° C.*	%		*m. p. s.*
9:15 a. m....	720.8	17.6	40	e.	4.9	526	720.8	17.6	40	e.	4.9
9:22 a. m....	720.7	17.8	39	e.	4.0	838	694.9	15.9	......	e.	....
9:37 a. m....	720.7	18.0	39	ese.	4.0	1184	667.3	16.3	......	se.	....
9:57 a. m....	720.6	18.0	42	ese.	4.5	1813	619.2	11.2	......	s.	....
10:39 a. m....	720.5	18.2	42	se.	3.1	2331	581.5	7.3	......	ssw.	....
11:00 a. m....	720.5	18.4	42	se.	2.7	3154	525.5	1.3	......	ssw.	....
11:25 a. m....	720.5	18.2	43	se.	3.6	4218	460.2	− 4.2	......	ssw.	....
12:28 p. m....	720.0	18.9	40	sse.	5.4	5238	404.1	−10.1	......	sw.	....
1:16 p. m....	719.3	19.7	39	sse.	4.5	4311	454.6	− 5.1	......	sw.	....
2:16 p. m....	718.7	20.6	43	s.	5.4	3476	504.8	0.4	......	sw.	....
2:46 p. m....	718.6	20.3	43	s.	7.2	2607	560.2	5.5	......	ssw.	....
3:15 p. m....	718.6	19.4	44	sse.	8.9	2019	602.6	9.7	......	ssw.	....
3:32 p. m....	718.5	19.3	46	sse.	8.0	1395	648.8	12.8	......	ssw.	....
4:02 p. m....	718.5	18.8	50	sse.	8.0	526	718.5	18.8	50	sse.	8.0
Nov. 2.											
7:38 a. m....	716.0	12.2	91	s.	5.8	526	716.0	12.2	91	s.	5.8
8:57 a. m....	715.8	14.4	85	s.	3.6	906	684.4	12.1	......	sw.	....
9:10 a. m....	715.7	15.0	82	s.	4.5	1393	645.7	10.2	......	wsw.	....
9:26 a. m....	715.6	15.1	82	s.	4.5	1930	605.0	6.7	......	wsw.	....
9:42 a. m....	715.4	15.2	82	s.	4.9	2321	576.5	3.7	......	wsw.	....
10:03 a. m....	715.3	16.0	79	s.	4.9	2792	544.0	0.2	......	wsw.	....
11:10 a. m....	714.9	18.6	71	ssw.	4.5	3669	488.6	− 3.3	......	wsw.	....
1:12 p. m....	713.7	20.5	57	s.	5.4	4737	427.3	− 8.3	......	wsw..	....
2:33 p. m....	713.3	21.2	39	sw.	8.5	4048	466.6	− 3.4	......	wsw.	....
3:08 p. m....	713.2	20.5	37	wsw.	8.9	2729	547.7	0.3	......	wsw.	....
3:48 p. m....	713.2	20.4	39	wsw.	7.2	1277	653.1	12.2	......	wsw.	....
4:00 p. m....	713.2	20.8	40	wsw.	5.4	857	686.3	16.6	......	wsw.	....
4:06 p. m....	713.2	20.6	40	w.	5.4	526	713.2	20.6	40	w.	5.4

November 1.—Six kites were used; lifting surface, 38.3 sq. m. Wire out., 9000 m.; at maximum altitude, 8100 m.

The sky was cloudless at the beginning. A few Ci.-St. from the west appeared at 10:23 a. m. These increased gradually to 8/10 by the end of the flight. A solar halo was observed from 11:57 a. m. to 3:35 p. m.

Low pressure was central over Iowa. Centers of high pressure were off the Carolina coast and over New Brunswick.

November 2.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 9000 m.; at maximum altitude, 8000 m.

From a few to 7/10 St. Cu. from the southwest were observed.

A low was central over Lake Huron. High pressure prevailed off the Atlantic coast.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.											
Nov. 3.	mm.	° C.	%		m. p. s.	Meters.	mm.	° C.	%		m. p. s.
7:24 a. m....	714.4	8.4	59	nw.	5.8	526	714.4	8.4	59	nw.	5.8
7:29 a. m....	714.4	8.4	59	wnw.	5.8	862	686.2	5.9	......	wnw.	....
7:45 a. m....	714.5	8.2	60	wnw.	4.9	1262	653.0	2.5	......	wnw.	....
8:10 a. m....	714.6	7.9	62	wnw.	4.5	1803	610.5	− 2.0	......	wnw.	....
8:33 a. m....	714.6	7.8	63	wnw.	5.4	2449	562.7	− 3.0	......	nw.	....
8:47 a. m....	714.6	8.1	63	wnw.	4.9	2824	536.5	− 5.1	......	nw.	....
9:02 a. m....	714.6	8.5	63	wnw.	6.3	2966	527.1	− 5.2	......	nw.	....
9:12 a. m....	714.5	8.8	63	wnw.	7.2	3491	494.2	− 4.5	......	nw.	....
9:42 a. m....	714.3	9.6	59	wnw.	9.4	4428	436.8	−11.0	......	nw.	....
11:03 a. m....	714.0	11.2	48	wnw.	10.7	3842	472.3	− 7.5	......	nw.	....
11:23 a. m....	713.8	11.2	46	wnw.	8.9	3103	518.6	− 3.1	......	nw.	....
11:27 a. m....	713.8	11.3	46	wnw.	8.9	3000	525.3	− 3.8	......	nw.	....
11:37 a. m....	713.8	11.2	46	wnw.	8.9	2236	578.3	− 0.1	......	nw.	....
11:45 a. m....	713.7	11.3	47	wnw.	8.9	1948	599.4	− 2 9	......	wnw.	....
12:03 p. m....	713.5	11.2	44	nw.	8.0	1185	658.6	3.0	......	wnw.	....
12:14 p. m....	713.3	11.8	44	wnw.	9.8	870	684.4	6.1	......	wnw.	....
12:21 p. m....	713.1	11.8	44	wnw.	9.4	526	713.1	11.8	44	wnw.	9.4
Nov. 4.											
7:19 a. m....	711.2	7.8	56	wnw.	8.5	526	711.2	7.8	56	wnw.	8.5
7:27 a. m....	711.3	7.9	55	wnw.	8.0	952	675.3	4.6	......	nw.	....
7:38 a. m....	711.4	7.8	56	wnw.	7.2	1408	638.4	1.0	......	nw.	....
7:52 a. m....	711.6	7.8	56	wnw.	5.4	1889	601.4	− 2.3	......	nw.	....
8:17 a. m....	711.6	8.3	56	wnw.	6.3	2270	573.0	− 6.1	......	nw.	....
9:08 a. m....	711.5	9.6	54	wnw.	5.4	3106	515.1	−11.5	......	nw.	....
9:18 a. m....	711.5	10.1	51	wnw.	5.8	3194	509.4	− 8.8	......	nw.	....
10:26 a. m....	711.3	12.2	39	wnw.	11.2	3933	463.0	−15.6	......	nw.	....
11:07 a. m....	711.0	13.1	29	wnw.	13.0	3114	515.1	− 9.2	......	wnw.	....
11:12 a. m....	711.0	13.2	29	wnw.	12.5	3059	518.8	−11.8	......	wnw.	....
1:14 p. m....	709.4	14.0	22	wnw.	17.4	2549	553.5	− 5.3	......	wnw.	....
2:44 p. m....	709.2	13.4	28	wnw.	17.4	1906	599.6	− 0.6	......	nw.	....
3:12 p. m....	709.4	12.6	36	wnw.	17.9	1233	651.4	5.3	......	nw.	....
3:28 p. m....	709.7	11.9	32	nw.	16.5	526	709.7	11.9	32	nw.	16.5

November 3.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 9000 m.; at maximum altitude, 7650 m.

A few Cu. from the west-northwest at the beginning, increased to 2/10 by the end of the flight. A few A.-Cu. were present from 9:26 to 10:07 a. m.

Low pressure was central north of the Lakes. An extensive area of high pressure was central over Colorado.

November 4.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 9600 m.; at maximum altitude, 9300 m.

St.-Cu., from the west-northwest, at an altitude of about 2800 m., increased from few at the beginning to 7/10 at the close of the flight.

Pressure was relatively high over the Gulf States and low over the Gulf of St. Lawrence.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m. Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	At different heights above sea. Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909.											
Nov. 5.	*mm.*	*° C.*	%		*m. p. s.*	*Meters.*	*mm.*	*° C.*	%		*m. p. s.*
8:41 a. m.	719.9	3.4	76	wnw.	8.5	526	719.9	3.4	76	wnw.	8.5
8:50 a. m.	719.9	3.8	76	wnw.	8.9	885	688.6	0.5	......	nw.	......
9:00 a. m.	720.0	4.0	73	wnw.	8.5	1329	651.7	1.3	......	nw.	......
9:10 a. m.	720.1	4.2	72	wnw.	7.2	1777	616.6	1.3	......	nnw.	......
9:28 a. m.	720.2	4.8	70	wnw.	8.0	2284	578.9	− 2.1	......	nnw.	......
9:49 a. m.	720.4	5.3	69	wnw.	8.9	3104	522.1	− 5.7	......	nnw.	......
11:54 a. m.	720.4	8.3	49	wnw.	9.4	2538	561.4	− 2.2	......	nnw.	......
12:24 p. m.	720.4	9.0	46	wnw.	8.5	1816	614.7	− 1.3	......	nnw.	......
12:40 p. m.	720.3	9.6	42	wnw.	8.9	1365	649.9	0.0	......	nw.	......
1:01 p. m.	720.3	10.0	36	wnw.	8.9	832	694.2	4.9	......	nw.	......
1:10 p. m.	720.3	9.8	42	wnw.	8.0	526	720.3	9.8	42	wnw.	8.0
Nov. 6.											
7:30 a. m.	724.6	6.2	57	ese.	4.0	526	724.6	6.2	57	ese.	4.0
7:38 a. m.	724.6	5.9	61	ese.	4.5	792	701.5	6.3	......	sse.	......
7:57 a. m.	724.7	5.8	62	se.	4.9	966	686.9	7.9	......	s.	......
8:30 a. m.	724.7	6.3	60	se.	4.9	1439	648.5	5.5	......	wsw.	......
8:45 a. m.	724.7	6.3	60	ese.	4.5	2374	577.9	0.2	......	wnw.	......
9:11 a. m.	724.7	6.3	64	se.	5.8	3494	501.1	− 5.4	......	wnw.	......
9:35 a. m.	724.8	7.0	64	ese.	5.8	4030	468.5	− 9.9	......	nw.	......
10:08 a. m.	724.8	7.4	64	se.	5.8	5146	404.6	−16.4	......	nw.	......
10:54 a. m.	724.8	8.4	61	se.	5.4	5929	364.5	−20.7	......	nw.	......
12:24 p. m.	724.3	9.0	65	se.	4.0	4788	423.7	−13.8	......	wnw.	......
12:53 p. m.	724.5	9.3	64	se.	2.7	3895	476.1	− 9.2	......	wnw.	......
1:11 p. m.	724.4	9.2	65	se.	2.2	3225	518.8	− 5.4	......	wnw.	......
1:30 p. m.	724.3	9.1	67	sse.	1.8	2578	562.9	− 1.2	......	wnw.	......
1:42 p. m.	724.2	9.2	64	se.	2.2	2001	604.8	2.3	......	wnw.	......
1:49 p. m.	724.2	9.0	65	ese.	1.8	1486	644.3	5.8	......	wnw.	......
1:59 p. m.	724.1	9.2	67	ese.	1.8	918	690.5	5.8	......	wsw.	......
2:04 p. m.	724.1	9.2	65	ssw.	1.8	526	724.1	9.2	65	ssw.	1.8
Nov. 7.											
8:14 a. m.	730.0	2.8	84	e.	4.9	526	730.0	2.8	84	e.	4.9
8:58 a. m.	730.2	2.7	80	e.	4.5	761	709.5	8.0	......	sse.	......
10:07 a. m.	730.6	3.3	80	e.	4.9	981	691.2	5.7	......	s.	......
10:12 a. m.	730.6	3.2	80	e.	4.9	1543	645.4	7.5	......	ssw.	......
10:19 a. m.	730.7	3.8	78	e.	5.4	1116	680.0	5.2	......	ssw.	......
10:28 a. m.	730.7	4.0	78	e.	5.4	768	709.5	7.7	......	s.	......
10:48 a. m.	730.9	4.6	79	e.	4.9	526	730.9	4.6	79	e.	4.9

November 5.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 8000 m.; at maximum altitude, 5000 m.

A few to 3/10 A.-Cu. from the west were visible from 9:22 a. m. to 12:12 p. m. The sky was cloudless during the remainder of the flight.

High pressure was central over West Virginia and low pressure over Nova Scotia.

November 6.—Seven kites were used; lifting surface, 44.6 sq. m. Wire out, 11000 m., at maximum altitude.

The sky was overcast until 9:30 a. m., with A.-St. from the northwest, and St.-Cu. from west-northwest; then with Ci.-St. and A.-St. from northwest. After noon the cloud cover became lower and moved from west-northwest. Rain fell from 1:24 to 1:35 p. m., and after 2:18 p. m. Solar halo, 10 to 11:30 a. m. The head kite was in St.-Cu. from 8:59 until 9:20 a. m.; altitude of base, 2600 m.

Pressure was high over the Lake region and middle Atlantic coast.

November 7.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 2500 m.; at maximum altitude, 1550 m.

The sky was overcast with A.-St. from the west.

Pressure was high over New York and New England and relatively low from Lake Superior southward to Texas.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.											
Nov. 8.	*mm.*	° *C.*	%		*m. p. s.*	*Meters.*	*mm.*	° *C.*	%		*m. p. s.*
7:52 a. m....	726.7	7.2	90	s.	5.4	526	726.7	7.2	90	s.	5.4
8:02 a. m....	726.7	7.4	90	s.	4.9	913	693.8	14.1	......	wsw.	....
8:19 a. m....	726.6	9.1	89	s.	5.4	1374	656.8	12.0	......	w.	....
8:34 a. m....	726.5	10.2	88	sw.	6.3	1858	619.8	7.5	......	w.	....
8:52 a. m....	726.4	11.2	82	sw.	4.9	2434	577.5	2.7	......	w.	....
10:10 a. m....	726.1	12.9	75	sw.	2.2	3274	520.2	− 0.8	......	w.	....
11:05 a. m....	725.9	14.1	67	se.	2.2	4576	440.1	−12.2	......	w.	....
11:14 a. m....	725.8	14.4	67	se.	2.2	4910	421.4	−11.7	......	w.	....
12:00 m.......	725.3	15.6	65	se.	2.2	5519	388.9	−14.7	......	w.	....
12:42 p. m....	724.8	17.2	60	s.	2.7	5150	408.0	−12.9	......	w.	....
12:50 p. m....	724.7	17.4	60	s.	3.1	5082	411.8	−14.0	......	w.	....
1:27 p. m....	724.4	17.8	60	s.	3.6	4377	451.5	− 8.8	......	w.	....
2:25 p. m....	724.1	18.2	61	sw.	3.6	3376	512.7	− 1.0	......	w.	....
2:37 p. m....	724.1	18.0	62	s.	2.7	3170	525.9	− 1.8	......	w.	....
3:03 p. m....	724.0	18.4	59	se.	2.7	2658	560.6	2.1	......	w.	....
3:30 p. m....	723.8	17.4	65	se.	2.7	1804	621.6	6.5	......	w.	....
3:48 p. m....	723.8	17.2	64	se.	2.7	1372	655.0	12.0	......	w.	....
4:00 p. m....	723.7	17.0	64	se.	3.1	909	692.0	15.7	......	sw.	....
4:11 p. m....	723.6	17.0	64	se.	3.6	526	723.6	17.0	64	se.	3.6
Nov. 9.											
7:38 a. m....	727.7	7.4	95	ne.	5.4	526	727.7	7.4	95	ne.	5.4
7:54 a. m....	727.8	7.4	96	nne.	4.0	1030	684.6	6.1	......	ene.	....
10:40 a. m....	728.6	6.2	97	ne.	3.6	1437	651.7	4.0	......	e.	....
11:10 a. m....	728.7	6.2	99	ne.	3.1	993	688.2	3.8	......	e.	....
11:22 a. m....	728.6	6.2	100	ne.	3.1	526	728.6	6.2	100	ne.	3.1
Nov. 10.											
11:38 a. m....	730.2	5.4	94	se.	5.8	526	730.2	5.4	94	se.	5.8
12:00 m.......	730.0	5.8	92	se.	5.6	886	698.7	6.9	......	s.	....
12:15 p. m....	729.9	6.4	90	se.	5.4	1190	673.0	4.0	......	ssw.	....
1:48 p. m....	729.2	8.2	77	se.	6.7	2743	556.5	1.0	......	wsw.	....
2:10 p. m....	729.0	8.6	76	se.	5.8	2152	598.3	4.8	......	sw.	....
2:20 p. m....	728.9	8.8	76	se.	5.8	1672	634.1	8.8	......	sw.	....
2:30 p. m....	728.8	9.2	74	se.	5.4	1450	651.2	7.2	......	sw.	....
2:43 p. m....	728.7	8.8	76	se.	5.4	872	698.7	5.3	......	sse.	....
2:47 p. m....	728.6	9.0	76	se.	5.4	526	728.6	9.0	76	se.	5.4

November 8.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 11000 m.; at maximum altitude, 10600 m.

There were from 1/10 to 8/10 A. St. from the west.

Centers of high pressure were over North Carolina and Minnesota and a trough of relatively low pressure extended from the lower St. Lawrence southwestward.

November 9.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 2700 m.; at maximum altitude, 2100 m.

The sky was covered with low St. from the northeast. Light fog after 9 a. m. Misting after 10 a. m.

High pressure, central north of Lake Ontario, covered the United States east of the Rocky Mountains.

November 10.—Four kites were used; lifting surface, 25.2 sq. m. Wire out 4500 m., at maximum altitude, 3600 m.

St. from the southwest diminished from 10/10 at the beginning to a few by 12:56 p. m. The head kite was in the clouds at 12:03 and at 12:37 p. m.

Pressure was high over southern New England and low over North Dakota.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909. Nov. 11.	mm.	° C.	%		m. p. s.	Meters.	mm.	° C.	%		m. p. s.
2:18 p. m.	725.1	14.6	67	sse.	4.5	526	725.1	14.6	67	sse.	4.5
2:27 p. m.	725.1	14.9	67	sse.	5.4	679	712.0	12.4	......	sse.	....
2:39 p. m.	725.1	15.3	67	sse.	4.5	726	708.2	16.2	......	s.	....
4:20 p. m.	724.9	15.2	65	sse.	5.4	1269	663.9	12.1	......	ssw.	....
4:38 p. m.	724.9	14.8	67	sse.	4.9	1893	615.9	7.5	......	ssw.	....
4:51 p. m.	724.9	14.7	67	sse.	5.4	1696	630.7	9.3	......	ssw.	....
4:59 p. m.	724.9	14.6	67	sse.	5.4	1361	656.5	11.4	......	ssw.	....
5:06 p. m.	724.9	14.6	67	sse.	4.9	879	695.2	14.5	......	s.	....
5:11 p. m.	724.9	14.6	67	sse.	4.9	700	710.1	13.0	......	sse.	....
5:14 p. m.	724.9	14.6	67	sse.	4.9	526	724.9	14.6	67	sse.	4.9
Nov. 12.											
7:36 a. m.	723.7	11.0	82	w.	6.3	526	723.7	11.0	82	w.	6.3
10:20 a. m.	723.6	15.4	71	w.	5.4	904	692.2	16.2	......	nw.	....
11:38 a. m.	723.1	17.3	51	w.	4.5	1221	666.3	13.2	......	nw.	....
11:48 a. m.	723.0	17.3	53	w.	4.5	856	695.7	16.4	......	nw.	....
12:02 p. m.	722.8	17.6	54	nw.	4.5	526	722.8	17.6	54	nw.	4.5

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Nov. 13.											
4:50 p. m.	726.7	16.0	74	e.	4.5	526	726.7	16.0	74	e.	4.5
5:05 p. m.	726.7	15.8	74	e.	4.9	1844	621.3	8.9	......	se.	....
5:37 p. m.	726.8	15.6	75	e.	4.9	526	726.8	15.6	75	e.	4.9
Nov. 14.											
3:04 p. m.	728.7	13.0	77	ssw.	1.8	526	728.7	13.0	77	ssw.	1.8
3:18 p. m.	728.7	13.2	77	sse.	1.8	1030	686.1	10.1	......	ssw.	....
3:34 p. m.	728.7	13.1	77	s.	1.8	920	695.2	10.7	......	s.	....
3:50 p. m.	728.7	12.8	79	sse.	1.8	809	704.5	10.2	......	sse.	....
4:00 p. m.	728.7	12.6	79	sse.	1.3	526	728.7	12.6	79	sse.	1.3

November 11.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 3000 m.; at maximum altitude, 1700 m.

Dense haze prevailed.

At 8 a. m. pressure was low over the upper Mississippi Valley and high over Virginia.

November 12.—Six kites were used; lifting surface, 38.3 sq. m. Wire out, 3350 m.; at maximum altitude, 2400 m.

The sky was cloudless.

High pressure, central over western Virginia, covered the eastern United States.

November 13.—One balloon was used; capacity, 31.1 cu. m. Wire out, 1800 m.

A few A.-St. were visible near the eastern horizon.

High pressure was central over Quebec and low over Texas.

November 14.—One balloon was used; capacity, 31.1 cu. m. Wire out, 1500 m.

A few St. from the south-southwest were observed.

High pressure was central over the north Atlantic coast and low pressure over Minnesota.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909 Nov. 15.	mm.	°C.	%		m. p. s.	Meters.	mm.	°C.	%		m. p. s.
10:47 a. m.	725.6	14.8	69	w.	5.4	526	725.6	14.8	69	w.	5.4
10:54 a. m.	725.6	15.0	67	w.	4.9	920	692.6	14.7	......	wnw.	....
11:06 p. m.	725.4	15.6	66	w.	4.0	1469	648.6	10.8	......	wnw.	....
1:10 p. m.	724.5	16.8	64	w.	4.0	1965	610.6	8.4	......	wnw.	....
1:40 p. m.	724.3	17.2	64	wnw.	4.5	2681	559.4	3.6	......	wnw.	....
2:08 p. m.	724.1	17.5	63	wnw.	4.0	3567	500.2	− 2.7	......	wnw.	....
2:40 p. m.	724.0	18.3	58	wnw.	4.0	4354	454.1	− 6.3	......	wnw.	....
3:34 p. m.	723.9	17.8	58	wnw.	3.1	5589	387.7	−12.3	......	wnw.	....
4:10 p. m.	723.9	17.1	64	wnw.	4.5	4922	422.1	− 8.7	......	wnw.	....
4:33 p. m.	723.9	16.8	65	wnw.	4.0	3256	520.9	0.9	......	wnw.	....
4:53 p. m.	723.9	16.6	67	wnw.	4.5	2700	557.6	3.5	......	wnw.	....
5:06 p. m.	723.9	16.6	69	wnw.	5.4	1925	612.4	5.3	......	wnw.	....
5:16 p. m.	723.9	16.6	69	wnw.	6.3	1336	657.4	8.8	......	wnw.	....
5:26 p. m.	723.9	16.4	71	wnw.	6.3	900	692.6	12.3	......	wnw.	....
5:39 p. m.	723.9	16.4	71	wnw.	8.0	526	723.9	16.4	71	wnw.	8.0
Nov. 16.											
7:43 a. m.	722.4	11.3	90	se.	4.9	526	722.4	11.3	90	se.	4.9
7:53 a. m.	722.4	11.4	89	se.	5.4	879	692.7	12.0	......	s.	....
8:01 a. m.	722.4	11.4	89	se.	5.8	1219	665.1	12.5	......	ssw.	....
8:11 a. m.	722.3	11.5	90	se.	5.8	1456	646.5	9.2	......	sw.	....
8:31 a. m.	722.1	11.2	92	se.	6.3	1966	607.7	5.5	......	sw.	....
8:47 a. m.	722.0	11.0	94	se.	5.8	2303	582.9	2.0	......	sw.	....
8:55 a. m.	721.9	11.0	94	se.	6.3	2522	567.2	0.8	......	sw.	....
8:58 a. m.	721.9	11.0	94	se.	6.3	2848	544.8	2.5	......	sw.	....
9:21 a. m.	721.8	11.4	92	se.	7.2	3585	496.9	− 1.1	......	sw.	....
9:40 a. m.	721.7	11.8	89	se.	4.5	4137	463.5	− 3.5	......	wsw.	....
10:00 a. m.	721.6	12.0	89	se.	6.7	4590	437.5	− 6.5	......	wsw.	....
10:21 a. m.	721.5	12.4	85	se.	5.8	4933	418.5	− 8.5	......	wsw.	....
10:43 a. m.	721.5	12.6	83	se.	5.8	5587	384.5	−13.0	......	wsw.	....
10:53 a. m.	721.4	13.0	79	se.	6.3	2645	557.9	1.7	......	sw.	....
11:54 a. m.	720.1	15.3	75	se.	6.3	2398	574.7	2.5	......	ssw.	....
12:34 p. m.	718.9	15.4	71	se.	6.3	1926	607.7	4.5	......	ssw.	....
1:00 p. m.	718.8	14.8	71	se.	6.7	526	718.1	14.8	71	se.	6.7

November 15.—Seven kites were used; lifting surface, 44.6 sq. m. Wire out, 10000 m.; at maximum altitude, 9200 m.

At the beginning there were about 2/10 A.-Cu. from the west-northwest. These gradually became heavier and lower until during the latter part of the flight 10/10 St.-Cu. were observed. The base of the clouds was found at an altitude of about 4400 m. on the ascent while on the descent the kites were in the clouds above 1900 m.

Centers of high pressure were over North Carolina and South Dakota. Low pressure was central over the lower St. Lawrence.

November 16.—Eight kites were used; lifting surface, 50.4 sq. m. Wire out, 11000 m., at maximum altitude.

St.-Cu. from the southwest decreased from 10/10 at the beginning to 2/10 at the end of the flight. After 10:34 a. m. from 4/10 to 5/10 A.-St., from the west-southwest appeared. The head kite was hidden by clouds from 8:58 to 10:40 a. m., and for a short interval at 10:55 a. m.

A low was central over Iowa and a high over Lake Ontario.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.											
Nov. 17.	*mm.*	°*C.*	%		*m. p. s.*	*Meters.*	*mm.*	°*C.*	%		*m. p. s.*
10:35 a. m....	709.8	10.8	56	nw.	17.0	526	709.8	10.8	56	nw.	17.0
10:39 a. m....	709.8	10.9	52	wnw.	17.0	852	682.5	7.1	......	wnw.	....
10:54 a. m....	710.0	10.6	52	wnw.	17.0	1062	665.3	4.2	......	wnw.	....
11:21 a. m....	710.1	9.8	48	wnw.	12.5	1322	644.3	1.5	......	w.	....
11:29 a. m....	710.1	9.3	51	nw.	11.6	1414	637.1	3.3	......	wsw.	....
11:42 a. m....	710.2	8.9	53	nw.	10.7	1745	611.3	− 1.3	......	wsw.	....
11:58 a. m....	710.3	8.6	54	nw.	13.4	2273	571.9	− 7.1	......	wsw.	....
12:18 p. m....	710.3	8.2	51	wnw.	16.1	3416	493.8	−10.9	......	w.	....
1:31 p. m....	710.8	5.4	56	wnw.	14.3	2450	557.0	− 3.3	......	w.	....
2:02 p. m....	711.2	5.5	56	wnw.	16.1	2330	566.0	− 9.7	......	w.	....
2:26 p. m....	711.2	4.7	52	wnw.	16.1	1860	601.1	− 8.4	......	w.	....
2:32 p. m....	711.2	4.7	52	wnw.	16.1	1731	611.3	− 2.9	......	wnw.	....
2:37 p. m....	711.2	4.7	52	wnw.	16.1	1499	629.5	− 7.3	......	wnw.	....
3:00 p. m....	711.2	4.0	58	wnw.	16.1	990	671.1	− 4.0	......	wnw.	....
3:12 p. m....	711.2	4.4	58	wnw.	17.9	526	711.2	4.0	58	wnw.	17.9
Nov. 18.											
8:38 a. m....	718.5	− 1.0	70	wnw.	11.6	526	718.5	− 1.0	70	wnw.	11.6
8:46 a. m....	718.6	− 0.9	70	wnw.	10.7	856	689.3	− 5.9	......	wnw.	....
9:05 a. m....	718.7	− 1.0	72	wnw.	12.5	1322	648 2	−11.0	......	nw.	....
9:20 a. m....	718.8	− 0.6	66	wnw.	16.5	1797	610.4	−15.7	......	nw.	....
9:48 p. m....	718.9	− 0.7	68	wnw.	13.4	2274	572.9	−15.6	......	nw.	....
10:00 a. m....	719.0	− 0.9	68	wnw.	13.9	2604	548.3	−19.5	......	nw.	....
10:24 a. m....	719.0	− 0.4	66	wnw.	14.3	3010	519.0	−24.0	......	nw.	....
10:30 a. m....	719.0	− 0.3	64	wnw.	14.3	3216	504.5	−23.2	......	nw.	....
10:43 a. m....	719.1	0.0	64	wnw.	13.4	3530	483.2	−25.5	......	nw.	....
10:53 a. m....	719.1	0.2	62	wnw.	13.4	3282	500.7	−22.2	......	nw.	....
11:08 a. m....	719.1	0.0	58	wnw.	15.2	2966	523.0	−17.5	......	nw.	....
11:25 a. m....	719.1	0.0	59	wnw.	15.2	2453	560.0	−16.3	......	nw.	....
11:38 a. m....	719.2	0.0	64	wnw.	17.4	2086	588.0	−14.3	......	nw.	....
11:43 a. m....	719.2	0.0	64	wnw.	15.6	1931	600.2	−16.3	......	nw.	....
12:06 p. m....	719.2	− 0.6	70	wnw.	15.2	1328	649.2	−10.8	......	nw.	....
12:16 p. m....	719.3	− 0.6	70	wnw.	15.6	864	689.3	− 6.0	......	nw.	....
12:23 p. m....	719.3	− 0.5	77	wnw.	14.8	526	719.3	− 0.5	77	wnw.	14.8

November 17.—Three kites were used; lifting surface, 16.2 sq. m Wire out, 5300 m.; at maximum altitude, 5250 m.

During the flight about 3/10 St.-Cu. from the west-northwest were present.

An active low was central over Ontario and high pressure was central over Utah.

November 18.—Four kites were used; lifting surface, 21.6 sq. m. Wire out, 7500 m.; at maximum altitude, 6900 m.

From 8/10 to 10/10 St.-Cu. from the northwest prevailed. The kites were in the clouds most of the time above 1200 m. Light snow flurries occurred until 10:33 a. m., and from 11:31 a. m. until after the close of the flight.

At 8 a. m. pressure was high over the lower Mississippi Valley and Texas and low over the Gulf of St. Lawrence.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m. Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	At different heights above sea. Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909.											
Nov. 19.	mm.	°C.	%		m. p. s.	Meters.	mm.	°C.	%		m. p. s.
8:52 a. m....	720.2	− 1.6	64	s.	6.7	526	720.2	− 1.6	64	s.	6.7
9:08 a. m....	720.2	− 1.6	64	s.	5.4	805	695.4	− 1.6	......	sw.	....
9:25 a. m....	720.2	− 1.2	61	s.	5.4	1390	645.7	− 6.0	......	w.	....
9:30 a. m....	720.1	− 1.2	61	s.	4.9	1526	634.7	− 4.0	......	w.	....
9:40 a. m....	720.1	− 1.0	61	s.	4.9	1796	613.3	− 4.7	......	w.	....
10:07 a. m....	720.1	− 0.8	61	s.	3.6	2201	582.6	− 6.3	......	w.	....
10:34 a. m....	719.6	− 0.2	63	s.	3.1	2736	542.9	−11.4	......	w.	....
10:45 a. m....	719.4	− 0.2	63	s.	3.1	2957	527.3	−12.3	......	w.	....
11:13 a. m....	719.1	0.6	58	s.	3.1	2464	562.4	− 8.9	......	w.	....
11:45 a. m....	719.0	1.4	57	s.	3.6	2088	594.8	− 4.2	......	w.	....
11:58 a. m....	718.9	1.5	55	s.	3.6	1797	613.3	− 2.7	......	w.	....
12:11 p. m....	718.8	1.5	59	s.	3.6	1458	640.0	− 0.6	......	w.	....
12:22 p. m....	718.7	1.5	59	s.	4.5	814	693.5	0.8	......	sw.	....
12:26 p. m....	718.4	1.0	58	s.	4.5	526	718.4	1.0	58	s.	4.5
Nov. 20.											
8:23 a. m....	716.8	10.2	25	sw.	4.5	526	716.8	10.2	25	sw.	4.5
8:36 a. m....	716.8	11.2	24	sw.	4.5	866	688.2	8.7	......	wsw.	....
8.49 a. m....	716.8	10.6	26	sw.	5.4	1574	631.3	4.0	......	w.	....
9:06 a. m....	716.8	11.1	27	s.	5.4	2056	595.2	6.5	......	w.	....
9:24 a. m....	716.7	12.1	27	s.	4.5	2572	558.8	3.2	......	wsw.	....
9:58 a. m....	716.6	12.0	25	s.	5.4	3316	509.2	− 2.1	......	wsw.	....
11:22 a. m....	716.1	12.4	26	s.	5.8	4809	420.4	−17.8	......	wsw.	....
12:53 p. m....	715.3	15.2	24	ssw.	6.3	4109	460.7	−10.3	......	wsw.	....
1:20 p. m....	715.1	15.5	22	s.	6.3	3506	497.6	− 3.2	......	w.	....
1:54 p. m....	715.8	15,8	22	s.	5.8	2826	541.3	5.1	......	w.	....
2:31 p. m....	715.0	16.0	23	sw.	5.4	2259	580.3	2.0	......	w.	....
2:54 p. m....	715.0	16.0	23	ssw.	5.4	1913	605.4	3.9	......	w.	....
3:08 p. m....	715.0	15.9	24	ssw.	5.4	1427	642.3	8.2	......	wsw.	....
3:18 p. m....	715.0	16.0	23	ssw.	6.3	804	692.0	13.1	......	ssw.	....
3:23 p. m....	715.0	16.1	24	ssw.	5.4	526	715.0	16.1	24	ssw.	5.4
Nov. 21.											
8:09 a. m....	716.8	13.8	42	sw.	5.8	526	716.8	13.8	42	sw.	5.8
8:20 a. m....	716.8	14.4	40	sw.	5.4	893	686.3	11.5	......	sw.	....
8:35 a. m....	716.9	14.3	40	wsw.	4.0	1416	644.3	6.5	......	w.	....
8:44 a. m....	716.9	13.8	44	wsw.	4.5	1847	611.3	3.6	......	wnw.	....
9:00 a. m....	716.9	13.9	42	wsw.	4.5	2268	580.4	1.0	......	wnw.	....
9:11 a. m....	716.9	14.4	42	wsw.	6.3	2633	555.1	5.0	......	wnw.	....
9:32 a. m....	716.9	15.2	44	wsw.	6.7	3073	525.8	2.0	......	w.	....
9:56 a. m....	716.9	16.0	45	wsw.	4.9	2642	555.1	5.3	......	w.	....
10:00 a. m....	716.9	16.0	45	sw.	4.9	2278	580.4	1.5	......	wnw.	....
10:45 a. m....	716.9	15.8	43	sw.	4.5	1587	631.4	5.5	......	nw.	....
11:02 a. m....	716.9	16.2	40	sw.	3.1	1296	653.9	6.9	......	w.	....
11:12 a. m....	716.9	16.5	38	sw.	4.5	895	686.3	11.0	......	sw.	....
11:25 a. m....	716.9	15.6	38	sw.	4.0	526	716.9	15.6	38	sw.	4.0

November 19.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 6000 m., at maximum altitude.

There were 8/10 to 10/10 A.-Cu. from the west. The head kite was obscured by clouds from 10:22 to 11:13 a. m., except at short intervals.

Pressure was high over the Carolinas and low over the Gulf of St. Lawrence.

November 20.—Five kites were used; lifting surface, 32 sq. m. Wire out, 10500 m.; at maximum altitude, 10100 m.

About 2/10 Ci.-St. from the west were present during the flight.

Low pressure was central north of Lake Superior and high pressure off the south Atlantic coast.

November 21.—Three kites were used; lifting surface, 19.4 sq. m. Wire out, 5000 m., at maximum altitude.

There were 3/10 to 8/10 A.-Cu. from the west. The head kite entered the clouds at 9:20 and emerged at 9:36 a. m.

Pressure was high over South Carolina and low over Illinois and Quebec.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.											
Nov. 22.	mm.	°C.	%		m. p. s.	Meters.	mm.	°C.	%		m. p. s.
7:38 a. m....	715.7	16.4	54	s.	4.5	526	715.7	16.4	54	s.	4.5
7:54 a. m....	715.5	16.4	56	s.	4.0	906	684.4	14.6	......	s.	....
8:13 a. m....	715.4	16.9	57	s.	3.6	1659	625.2	7.4	......	ssw.	....
8:40 a. m....	715.2	17.0	56	s.	3.6	2220	583.3	1.2	......	ssw.	....
9:11 a. m....	715.0	16.9	55	s.	3.6	3047	526.6	− 2.6	......	ssw.	....
9:36 a. m....	714.9	18.2	48	s.	4.0	3870	474.2	−10.0	......	sw.	....
9:58 a. m....	714.8	18.6	47	s.	4.9	4498	437.8	−13.5	......	sw.	....
10:35 a. m....	714.6	18.6	42	s.	5.8	5081	404.6	−19.5	......	sw.	....
11:39 a. m....	713.3	18.6	45	se.	4.0	4476	437.8	−14.0	......	sw.	....
12:11 p. m....	712.6	17.6	51	se.	4.5	3812	476.1	− 9.4	......	sw.	....
1:24 p. m....	711.9	18.7	47	se.	4.5	3013	527.5	− 0.9	......	sw.	....
1:54 p. m....	711.2	18.4	48	se.	6.3	2424	566.5	2.4	......	sw.	....
2:11 p. m....	711.0	18.6	49	se.	6.3	1561	629.0	8.5	......	sw.	....
3:01 p. m....	710.3	18.6	49	se.	8.0	843	684.4	14.4	......	sse.	....
3:07 p. m....	710.1	18.6	49	se.	8.5	526	710.1	18.6	49	se.	8.5
Nov. 23.											
1:15 p. m....	709.0	1.8	77	nw.	17.9	526	709.0	1.8	77	nw.	17.9
1:20 p. m....	709.0	1.8	77	nw.	17.9	825	683.0	− 3.4	......	nnw.	....
1:28 p. m....	709.0	1.8	77	nw.	17.9	1005	667.7	− 4.2	......	n.	....
1:42 p. m....	709.0	1.8	76	nw.	17.9	1215	650.5	5.2	......	n.	....
2:06 p. m....	709.0	1.8	76	nw.	17.0	1552	624.2	2.4	......	nne.	....
3:14 p. m....	709.6	2.2	68	nw.	14.3	2123	581.6	− 4.5	......	nne.	....
4:02 p. m....	710.0	2.2	68	nw.	10.7	1597	620.4	− 3.6	......	nne.	....
4:13 p. m....	710.1	2.2	68	nw.	11.6	1270	646.7	− 2.5	......	nne.	....
4:19 p. m....	710.2	2.2	68	nw.	10.7	1177	654.3	− 5.4	......	n.	....
4:26 p. m....	710.2	2.0	68	nw.	11.6	816	684.9	− 3.1	......	nnw.	....
4:32 p. m....	710.3	2.0	68	nw.	9.8	526	710.3	2.0	68	nw.	9.8
Nov. 24.											
10:20 a. m....	713.1	− 3.6	100	nw.	10.7	526	713.1	− 3.6	100	nw.	10.7
10:32 a. m....	713.1	− 3.6	100	nw.	11.2	784	690.1	− 6.4	......	nnw.	....
10:47 a. m....	713.1	− 3.6	100	nw.	9.8	1026	669.1	− 5.1	......	n.	....
11:33 a. m....	713.0	− 3.7	100	nw.	9.4	892	680.6	− 4.2	......	nnw.	....
11:56 a. m....	713.0	− 3.6	100	nw.	9.4	740	693.9	− 6.2	......	nnw.	....
12:11 p. m....	713.0	− 3.6	100	nw.	11.2	526	713.0	− 3.6	100	nw.	11.2

November 22.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 10500 m.; at maximum altitude, 10100 m.

About 8/10 Ci.-St. from the west were observed.

At 8 a. m. a well-developed low was central over the middle Mississippi Valley. Pressure was relatively high along the Altantic coast.

November 23.—Four kites were used; lifting surface 21.6 sq. m. Wire out, 5700 m.; at maximum altitude, 5400 m.

There were 6/10 to 9/10 A.-Cu. from the southwest.

High pressure was central over the Lakes. An area of low pressure, central over New Brunswick, extended southwestward along the Atlantic coast.

November 24.—Three kites were used; lifting surface, 16.2 sq. m. Wire out, 2200 m., at maximum altitude, 1200 m.

Light snow fell and dense fog prevailed during the flight.

Pressure was low off the North Carolina coast and high over the Gulf of St. Lawrence.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Nov. 25.	*mm.*	*° C.*	*%*		*m. p. s.*	*Meters.*	*mm.*	*° C.*	*%*		*m. p. s.*
10:09 a. m....	710.0	− 0.2	37	wnw.	17.0	526	710.0	− 0.2	37	wnw.	17.0
10:17 a. m....	709.9	0.4	44	wnw.	17.0	981	670.5	− 2.9	......	nw.	....
10:25 a. m....	709.9	0.6	42	wnw.	17.4	1259	647.6	2.8	......	n.	....
10:39 a. m....	709.8	1.0	47	wnw.	17.9	1429	634.2	5.1	......	n.	....
10:53 a. m....	709.7	1.4	53	wnw.	21.9	1360	640.0	6.8	......	nnw.	....
11:18 a. m....	709.7	2.2	62	wnw.	21.5	1029	666.7	0.0	......	n.	....
11:58 a. m....	709.6	3.6	65	wnw.	19.7	526	709.6	3.6	65	wnw.	19.7
Nov. 26.											
1:12 p. m....	721.6	6.8	59	nw.	15.2	526	721.6	6.8	59	nw.	15.2
1:16 p. m....	721.7	6.8	59	nw.	15.2	773	700.1	2.1	......	nw.	....
1:27 p. m....	721.7	7.0	60	nw.	15.2	1124	670.6	6.6	......	nnw.	....
1:42 p. m....	721.7	7.0	60	nw.	11.6	1449	644.7	8.1	......	nnw.	....
1:53 p. m....	721.8	7.2	60	nw.	12.5	1937	607.7	5.5	......	nnw.	....
2:08 p. m....	721.8	7.2	60	nw.	11.6	2410	573.6	2.9	....	nnw.	....
2:27 p. m....	721.9	7.5	58	nw.	11.2	2687	554.2	1.8	......	n.	....
4:35 p. m....	722.4	5.2	72	nw.	6.7	526	722.4	5.2	72	nw.	6.7

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Date and hour.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
Nov. 27.											
11:25 a. m....	724.9	6.7	63	nw.	3.6	526	724.9	6.7	63	nw.	3.6
11:45 a. m....	724.9	7.2	61	nw.	3.1	1688	630.9	11.4	......	nnw.	....
11:50 a. m....	724.9	8.0	58	nw.	3.1	1285	661.9	14.2	......	nnw.	....
12:03 p. m....	724.9	9.2	57	nw.	3.1	897	693.3	11.0	......	nnw.	....
12:11 p. m....	724.9	9.0	55	nw.	3.1	526	724.9	9.0	55	nw.	3.1

RESULTS OF KITE FLIGHTS.

Date and hour.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
Nov. 28.											
7:28 a. m....	723.9	7.6	53	wnw.	4.9	526	723.9	7.6	53	wnw.	4.9
7:39 a. m....	723.9	7.8	53	wnw.	5.8	924	690.2	13.9	......	wnw.	....
8:06 a. m....	723.9	7.8	52	wnw.	5.8	1245	664.4	13.3	......	nw.	....
8:42 a. m....	723.9	7.7	53	wnw.	6.3	1826	620.0	9.9	......	nw.	....
9:26 a. m....	723.9	9.2	48	wnw.	5.4	2596	564.8	5.0	......	nw.	....
9:35 a. m....	723.8	9.4	47	wnw.	5.4	2104	599.6	8.2	......	wnw.	....
9:45 a. m....	723.8	9.6	48	wnw.	6.3	1652	633.0	11.3	......	nw.	....
9:55 a. m....	723.8	10.1	44	wnw.	6.3	1245	664.4	13.0	......	nw.	....
10:04 a. m....	723.8	10.1	44	wnw.	6.3	879	693.9	13.1	......	nw.	....
10:11 a. m....	723.7	10.4	45	w.	6.3	526	723.7	10.4	45	w.	6.3

November 25.—One kite was used; lifting surface, 5.4 sq. m. Wire out, 3000 m.; at maximum altitude, 2500 m.

About 2/10 St.-Cu. from the northwest were observed.

At 8 a. m. relatively high pressure extended from the Lake region to the Gulf of Mexico and a well-developed low was central off the coast of New Jersey.

November 26.—Two kites were used; lifting surface, 10.8 sq. m. Wire out, 5500 m.; at maximum altitude, 5300 m.

The sky was cloudless.

High pressure was central over West Virginia, low pressure off the New England coast.

November 27.—One balloon was used; capacity, 31.1 cu. m. Wire out, 1650 m., at maximum altitude.

A few Ci.-St. were visible near the horizon.

Pressure was high over the Atlantic coast States and low over Minnesota.

November 28.—Five kites were used; lifting surface, 32 sq. m. Wire out, 4500 m.; at maximum altitude, 3600 m.

About 3/10 Ci.-Cu. from the west were observed.

High pressure was central over West Virginia. Centers of low pressure were over Texas and Lake Huron.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909. Nov. 29.	mm.	°C.	%		m. p. s.	Meters.	mm.	°C.	%		m. p. s.
10:12 a. m....	718.1	7.3	83	nw.	12.5	526	718.1	7.3	83	nw.	12.5
10:19 a. m....	718.1	7.7	77	nw.	13.9	892	686.7	2.8	......	nnw.	....
10:37 a. m....	718.3	7.4	75	nw.	12.5	1362	648.0	− 0.4	......	nnw.	....
10:44 a. m....	718.3	7.4	75	nw.	13.0	1619	627.7	2.4	......	n.	....
11:08 a. m....	718.4	8.0	62	nw.	12.5	1790	614.7	0.3	......	n.	....
11:22 a. m....	718.4	7.7	57	nw.	12.5	2224	582.5	3.3	......	n.	....
11:45 a. m....	718.5	7.3	50	nw.	13.4	2660	551.9	1.6	......	n.	....
11:52 a. m....	718.5	7.2	49	nw.	13.9	2301	576.9	1.8	......	n.	....
12:36 p. m....	718.5	7.0	44	nw.	13.9	1911	605.5	0.8	......	n.	....
12:55 p. m....	718.5	6.7	41	nw.	14.3	1520	635.5	2.8	......	nne.	....
1:06 p. m....	718.5	7.0	39	nw.	12.1	1295	653.5	− 0.4	......	n.	....
1:26 p. m....	718.5	7.0	34	nw.	13.0	895	686.7	2.3	......	nnw.	....
1:34 p. m....	718.6	6.6	34	nw.	11.6	526	718.6	6.6	34	nw.	11.6
Nov. 30.											
8:10 a. m....	721.1	− 2.2	48	nw.	5.4	526	721.1	− 2.2	48	nw.	5.4
8:21 a. m....	721.2	− 2.3	50	nw.	5.4	891	689.1	2.0	......	n.	....
10:04 a. m....	721.5	− 0.5	47	nw.	5.8	1225	661.4	0.8	......	nne.	....
10:18 a. m....	721.4	0.0	46	nw.	4.5	2473	565.5	− 3.9	......	n.	....
10:33 a. m....	721.4	1.2	50	nw.	5.4	3110	521.5	− 7.9	......	nnw.	....
10:40 a. m....	721.4	0.6	41	nw.	6.7	3486	497.1	− 5.7	......	nnw.	....
10:45 a. m....	721.4	0.8	41	nw.	6.3	3724	482.0	− 6.7	......	nnw.	....
11:02 a. m....	721.3	1.3	42	nw.	5.4	3596	489.6	− 5.7	......	nnw.	....
11:21 a. m....	721.2	1.8	44	nw.	5.4	3358	504.6	− 8.1	......	nnw.	....
11:55 a. m....	721.0	2.7	47	nw.	6.3	3104	521.5	− 8.4	......	nnw.	....
1:32 p. m....	720.5	3.8	47	nw.	6.7	2047	596.1	− 1.0	......	nnw.	....
1:39 p. m....	720.5	3.7	48	nw.	7.2	2013	598.6	− 1.8	......	nnw.	....
1:58 p. m....	720.4	3.8	33	nw.	6.3	1420	644.8	− 0.7	......	n.	....
2:10 p. m....	720.4	3.6	40	nw.	5.8	526	720.4	3.6	40	nw.	5.8

RESULTS OF CAPTIVE BALLOON ASCENSIONS.

Dec. 1.											
4:45 p. m....	716.5	5.6	30	nnw.	0.9	526	716.5	5.6	30	nnw.	0.9
4:55 p. m....	716.5	5.2	29	nnw.	0.9	1069	670.2	1.9	......	nnw.	....
5:29 p. m....	716.5	4.9	32	nnw.	1.8	526	716.5	4.9	32	nnw.	1.8

November 29.—Three kites were used; lifting surface, 16.2 sq. m. Wire out, 4900 m.; at maximum altitude, 4600 m.

St.-Cu. from the north-northwest diminished from 8/10 at the beginning of the flight to few at the close. The head kite was in the clouds at intervals from 10:20 to 11 a. m.

At 8 a. m. pressure was high over the Lake region and low off the middle Atlantic coast.

November 30.—Four kites were used; lifting surface, 26.2 sq. m. Wire out, 5000 m.; at maximum altitude.

There were 1/10 to 3/10 A.-Cu. from the northwest.

High pressure, central over the St. Lawrence Valley, covered the eastern half of the country.

December 1.—One balloon was used; capacity, 31.1 cu. m. Wire out, 1450 m.

A few St. were visible near the horizon.

Pressure was high over Lake Ontario and low over Nova Scotia.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.											
Dec. 2.	mm.	°C.	%		m. p. s.	Meters.	mm.	°C.	%		m. p. s.
8:31 a. m....	713.2	− 0.3	39	wnw.	7.6	526	713.2	− 0.3	39	wnw.	7.6
8:40 a. m....	713.2	0.0	38	wnw.	8.0	856	684.8	6.2	......	nnw.	....
9:08 a. m....	713.1	0.7	36	wnw.	7.2	1212	655.3	2.3	......	nnw.	....
9:15 a. m....	713.1	1.0	34	wnw.	6.3	877	682.9	4.7	......	nnw.	....
10:22 a. m....	712.9	2.5	22	nw.	4.9	526	712.9	2.5	22	nw.	4.9
Dec. 3.											
8:18 a. m....	714.1	− 0.2	52	se.	3.6	526	714.1	− 0.2	52	se.	3.6
10:16 a. m....	714.3	1.6	46	se.	4.0	902	682.0	3.9	......	wsw.	....
10:35 a. m....	714.2	2.7	46	se.	4.0	1124	663.6	5.5	......	w.	....
10:47 a. m....	714.2	3.4	45	se.	3.6	1492	634.5	4.6	......	w.	....
11:17 a. m....	714.1	3.9	46	s.	3.1	2017	594.6	1.3	......	wnw.	....
11:52 a. m....	713.9	4.8	45	s.	3.1	2628	550.9	− 1.9	......	wnw.	....
12:38 p. m....	713.4	5.7	42	s.	3.1	3253	508.7	− 6.0	......	wnw.	....
2:21 p. m....	713.0	4.6	37	se.	3.1	4148	452.8	−10.9	......	wnw.	....
2:58 p. m....	713.1	6.5	36	se.	3.1	3337	503.0	− 7.1	......	wnw.	....
3:13 p. m....	713.1	6.4	36	se.	2.7	2921	530.3	− 3.3	......	wnw.	....
3:37 p. m....	713.1	5.9	40	se.	2.7	1778	611.8	2.1	......	wnw.	....
3:50 p. m....	713.1	5.3	42	se.	2.2	1229	654.4	5.5	......	w.	....
3:56 p. m....	713.1	5.5	44	se.	2.2	893	682.0	6.7	......	wsw.	....
4:00 p. m....	713.1	5.4	46	se.	2.7	760	693.1	5.2	......	wsw.	....
4:05 p. m....	713.1	5.1	43	se.	2.7	526	713.1	5.1	43	se.	2.7
Dec. 4.											
8:36 a. m....	715.4	8.1	79	wnw.	11.6	526	715.4	8.1	79	wnw.	11.6
8:44 a. m....	715.4	8.4	76	wnw.	12.5	862	686.8	4.6	......	wnw.	....
8:53 a. m....	715.5	8.4	76	wnw.	13.0	1130	664.7	3.0	......	wnw.	....
9:06 a. m....	715.5	8.4	74	wnw.	13.0	1337	648.0	7.5	......	nw.	....
9:35 a. m....	715.7	8.6	79	nw.	10.7	1874	607.4	7.1	......	nw.	....
9:47 a. m....	715.7	8.0	82	wnw.	10.7	2843	538.9	− 1.0	......	nw.	....
10:05 a. m....	715.8	7.9	83	wnw.	7.6	3578	491.0	− 7.6	......	nw.	....
10:29 a. m....	715.8	8.8	78	nw.	11.6	3876	472.8	− 7.4	......	nw.	....
10:38 a. m....	715.7	9.0	76	nw.	11.6	4320	446.3	−10.0	......	nw.	....
11:38 a. m....	715.6	9.0	74	nw.	12.5	4681	425.9	−13.3	......	nw.	....
12:24 p. m....	715.6	9.3	74	nw.	13.9	4325	446.3	−11.2	......	wnw.	....
12:55 p. m....	715.5	9.4	72	nw.	13.4	3906	470.9	− 8.5	......	wnw.	....
1:20 p. m....	715.5	9.8	70	nw.	12.5	3203	515.4	− 3.0	......	wnw.	....
1:30 p. m....	715.5	9.7	69	nw.	12.5	2795	542.6	0.5	......	wnw.	....
2:00 p. m....	715.5	10.0	68	nw.	10.7	1927	603.6	6.5	......	nw.	....
2:18 p. m....	715.5	10.4	66	nw.	10.7	1389	644.4	9.5	......	wnw.	....
2:37 p. m....	715.6	10.4	65	wnw.	10.7	1202	659.2	4.1	......	wnw.	....
2:46 p. m....	715.6	10.6	65	wnw.	10.7	957	679.3	5.3	......	wnw.	....
2:52 p. m....	715.6	10.2	66	wnw.	8.5	526	715.6	10.2	66	wnw.	8.5

December 2.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 2000 m., at maximum altitude.

There were a few Ci.-St. from the northwest during the flight.

At 8 a. m. there was a high over Virginia and a low over Iowa.

December 3.—Eight kites were used; lifting surface, 50.9 sq. m. Wire out, 7400 m.; at maximum altitude, 6500 m.

About 1/10 Ci.-St. from the west was present during the flight.

High pressure was central over Alberta and low pressure over Arizona.

December 4.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 9500 m.; at maximum altitude, 8000 m.

St. from the northwest increased from 6/10 at the beginning to 8/10 at 11:44 a. m. and then decreased to a few. About 1/10 A.-Cu. was visible from 9:47 to 11:44 a. m. The head kite was in the clouds except at intervals from 9:24 a. m. to 12:30 p. m.

A ridge of high pressure extended from northern Florida to Lake Erie. Pressure was low over Nova Scotia.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Dec. 5.	mm.	°C.	%		m. p. s.	Meters.	mm.	°C.	%		m. p. s.
10:20 a. m....	719.2	10.1	68	wnw.	1.3	526	719.2	10.1	68	wnw.	1.3
10:31 a. m....	719.1	12.4	62	wsw.	1.3	1459	642.8	7.3	......	w.	....
10:43 a. m....	719.1	11.8	63	wsw.	1.3	1154	666.9	9.6	......	wnw.	....
10:52 a. m....	719.0	12.8	64	sse.	1.3	860	690.8	10.6	......	wnw.	....
10:59 a. m....	719.0	12.4	63	sw.	1.3	682	705.7	9.5	......	wnw.	....
11:06 a. m....	718.9	12.6	65	ese.	1.3	526	718.9	12.6	65	ese.	1.3
Dec. 6.											
8:50 a. m....	717.2	3.8	29	nw.	16.1	526	717.2	3.8	29	nw.	16.1
8:55 a. m....	717.2	3.7	30	nw.	16.1	805	693.0	2.2	......	wnw.	....
9:03 a. m....	717.2	3.5	34	nw.	13.4	960	680.0	9.6	......	wnw.	....
9:13 a. m....	717.4	3.5	33	nw.	14.3	1259	656.1	11.0	......	wnw.	....
9:43 a. m....	717.8	3.7	29	nw.	13.9	2161	588.9	6.4	......	w.	....
10:04 a. m....	718.0	3.9	28	nw.	13.0	2736	548.9	2.6	....	w.	....
10:28 a. m....	718.0	3.9	30	nw.	12.5	2987	532.1	0.4	......	w	....
11:24 a. m....	718.1	4.3	29	nw.	12.5	3164	519.9	0.6	......	w.	....
11:55 a. m....	718.1	4.4	30	nw.	12.5	2586	558.3	4.7	......	w.	....
12:12 p. m....	718.0	4.6	28	nw.	12.5	1909	606.2	8.6	......	wnw.	....
12:27 p. m....	717.7	4.7	26	nw.	12.1	1580	630.7	5.6	......	wnw.	....
12:45 p. m....	717.4	4.8	26	nw.	13.4	1115	667.3	5.1	......	wnw.	....
12:54 p. m....	717.3	4.7	28	nw.	15.6	806	693.0	2.6	......	wnw.	....
1:03 p. m....	717.3	4.8	26	nw.	15.6	526	717.3	4.8	26	nw.	15.6
Dec. 7.											
8:26 a. m....	712.5	− 0.4	77	sse.	9.8	526	712.5	− 0.4	77	sse.	9.8
8:31 a. m....	712.4	− 0.3	77	sse.	8.5	869	682.6	0.3	......	sse.	....
8:40 a. m....	712.4	− 0.2	81	sse.	8.9	1248	651.3	4.3	......	s.	....
8:55 a. m....	712.2	− 0.2	71	se.	8.9	1572	625.9	8.0	......	s.	....
9:17 a. m....	712.2	− 0.2	76	se.	8.0	2247	576.6	5.6	......	ssw.	....
9:27 a. m....	712.2	− 0.2	76	se.	7.6	526	712.2	− 0.2	76	se.	7.6
Dec. 8.											
10:22 a. m....	712.0	− 1.6	55	wnw.	15.2	526	712.0	− 1.6	55	wnw.	15.2
10:30 a. m....	712.0	− 1.8	52	wnw.	13.9	851	683.3	− 7.0	......	wnw.	....
10:43 a. m....	712.1	− 1.6	56	wnw.	13.4	1118	660.3	−10.1	......	wnw.	....
10:53 a. m....	712.1	− 1.4	55	wnw.	11.2	1367	639.3	−12.6	......	wnw.	....
11:05 a. m....	712.1	− 1.4	54	nw.	12.1	1908	596.1	− 7.1	......	wnw.	....
11:19 a. m....	712.1	− 1.0	54	wnw.	10.7	2379	561.0	−10.6	......	wnw.	....
11:40 a. m....	712.1	− 1.0	54	wnw.	10.7	2723	536.4	11.1	......	wnw.	....
12:42 p. m....	712.0	− 0.7	53	wnw.	9.8	2448	555.9	−10.6	......	wnw.	....
1:26 p. m....	711.9	− 0.2	52	wnw.	7.6	1185	654.6	− 9.8	......	w.	....
1:36 p. m....	711.9	0.0	52	wnw.	7.6	962	673.7	− 7.2	......	w.	....
1:46 p. m....	711.9	0.3	50	wnw.	8.0	526	711.9	0.3	50	wnw.	8.0

December 5.—One balloon was used; capacity, 31.1 cu. m. Wire out, 1700 m.

A few Ci.-St. from the northwest were visible.

At 8 a. m. there was a moderate high over Virginia and a well-developed low was central over Wisconsin.

December 6.—Four kites were used; lifting surface, 22.5 sq. m. Wire out, 8000 m.; at maximum altitude, 6000 m.

About 9/10 A.-St., from the west, prevailed.

At 8 a. m. pressure was high over the Ohio Valley and low north of Lake Superior.

December 7.—Two kites were used; lifting surface, 10.8 sq. m. Wire out, 4000 m., at maximum altitude.

The sky was covered with St. from the south. Light rain fell until 9:05 a. m. The base of the clouds was about 1250 m. above sea level.

Low pressure was central over Ohio. Pressure was relatively high along the Atlantic coast.

December 8.—Two kites were used; lifting surface, 10.8 sq. m. Wire out, 5000 m.; at maximum altitude, 4800 m.

There were 3/10 to 4/10 Ci. from the west. About 2/10 A.-Cu. from the southwest, observed at the beginning of the flight, disappeared at 10:30 a. m. From 1/10 to a few St. from the west were visible from 10:50 a. m. to 12:26 p. m. A solar halo was observed.

Pressure was high over Kansas and low over Maine.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Dec. 9.	mm.	°C.	%		m. p. s.	Meters.	mm.	°C.	%		m. p. s.
1:10 p. m....	713.4	-5.8	51	wnw.	10.3	526	713.4	- 5.8	51	wnw.	10.3
1:31 p. m.	713.4	- 6.3	57	wnw.	10.7	947	675.5	-13.4	....	nw.	....
2:04 p. m....	713.4	- 6.6	52	wnw.	11.2	1319	643.0	-19.1	......	nw.	....
2:10 p. m....	713.4	- 6.3	50	wnw.	12.5	2110	579.1	-11.7	......	wnw.	....
2:34 p. m....	713.5	- 5.9	51	wnw.	12.1	2778	530.4	-16.4	......	wnw.	....
3:00 p. m....	713.5	- 6.3	53	wnw.	11.2	3412	486.7	-23.9	......	w.	....
3:13 p. m....	713.5	- 6.2	55	wnw.	9.8	3647	471.2	-25.6	......	w.	....
3:44 p. m....	713.6	- 6.4	60	wnw.	11.2	3410	486.7	-22.6	......	w.	....
4:02 p. m....	713.7	- 6.6	60	wnw.	9.8	2854	524.5	-15.1	......	w.	....
4:19 p. m....	713.8	- 6.8	68	wnw.	10.3	2526	547.9	-14.6	......	wnw.	....
4:30 p. m....	713.8	- 7.1	70	wnw.	12.1	1996	587.6	-15.6	....	wnw.	....
4:35 p. m....	713.9	- 7.2	70	wnw.	11.2	1566	622.5	-20.8	......	wnw.	....
4:44 p. m....	713.9	- 7.4	67	wnw.	11.6	1060	665.9	-15.1	.....	nw.	....
5:00 p. m....	714.0	- 7.7	57	wnw.	11.6	526	714.0	- 7.7	57	wnw.	11.6
Dec. 10.											
10:13 a. m....	719.5	- 7.5	60	wnw.	8.9	526	719.5	- 7.6	60	wnw.	8.9
10:33 a. m....	719.4	- 7.6	60	wnw.	8.9	744	699.4	-13.2	......	wnw.	....
10:47 a. m....	719.3	- 7.1	58	wnw.	11.6	1122	665.0	-18.2	......	wnw.	....
11:05 a. m....	719.2	- 6.9	56	wnw.	10.7	1766	611.0	- 8.8	......	nw.	....
11:16 a. m....	719.1	- 7.0	56	wnw.	11.6	2456	558.6	-12.4	......	nw.	....
11:45 a. m....	719.0	- 6.0	56	nw.	8.9	2700	541.1	- 9.8	......	nw.	....
12:10 p. m....	719.0	- 5.7	50	nw.	9.8	3318	499.3	-13.2	......	nw.	....
2:25 p. m....	718.6	- 5.0	47	nw.	9.8	526	718.6	- 5.0	47	nw.	9.8
Dec. 11.											
8:33 a. m....	723.3	- 7.2	67	nw.	4.5	526	723.3	- 7.2	67	nw.	4.5
8:56 a. m....	723.4	- 7.0	67	nw.	4.5	940	685.9	- 8.6	......	nw.	....
9:02 a. m....	723.4	- 7.0	68	nw.	4.5	1326	652.8	- 4.0	......	wnw.	....
9:22 a. m....	723.5	- 6.4	63	nw.	4.0	1741	619.5	- 5.2	......	wnw.	....
9:34 a. m....	723.7	- 6.2	64	wnw.	3.1	1988	600.4	- 7.1	......	wnw.	....
9:40 a. m....	723.8	- 6.1	66	wnw.	3.1	2477	564.2	- 4.2	......	wnw.	....
10:12 a. m....	724.1	- 5.6	65	nw.	3.6	3120	520.1	- 7.1	......	wnw.	....
11:52 a. m....	723.6	- 4.0	59	nw.	2.2	2192	585.5	- 1.7	......	wnw.	....
12:03 p. m....	723.5	- 3.6	55	wnw.	2.7	1990	600.4	- 1.9	......	wnw.	....
12:10 p. m....	723.4	- 3.4	52	wnw.	3.1	1626	628.8	- 6.2	......	wnw.	....
12:18 p. m....	723.3	- 2.9	54	wnw.	2.7	1419	645.4	- 4.3	......	wnw.	....
12:26 p. m....	723.3	- 2.4	51	wnw.	2.7	1048	676.8	- 7.5	......	w.	....
12:31 p. m....	723.2	- 2.2	50	nw.	2.7	526	723.2	- 2.2	50	nw.	2.7

December 9.—Four kites were used; lifting surface, 22.5 sq. m. Wire out, 7500 m., at maximum altitude.

There were 2/10 to 3/10 St.-Cu. from the west-northwest.

At 8 a. m. pressure was low over the Gulf of St. Lawrence and a ridge of high pressure extended from north of the Dakotas southward to Arkansas.

December 10.—Five kites were used; lifting surface, 27.2 sq. m. Wire out, 7050 m.; at maximum altitude, 6600 m.

At the beginning a few St.-Cu. from the northwest were present. These had disappeared at 1:34 p. m. A few Ci.-Cu. from the west appeared at 11:24 a. m. and they had increased to 3/10 by the end of the flight.

Centers of high pressure were over Kentucky and Manitoba. Low pressure was central over the Gulf of St. Lawrence.

December 11.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 6200 m.; at maximum altitude, 5000 m.

The sky was from 7/10 to 10/10 covered with St.-Cu. from the west-northwest. During the ascent the head kite entered the cloud base at an altitude of about 2000 m., but the clouds lowered somewhat during the flight, and in the descent the cloud base was found at 1600 m.

Pressure was high over the Lake region and Middle Atlantic States and low over Texas.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Dec. 12.	mm.	°C.	%		m. p. s.	Meters.	mm.	°C.	%		m. p. s.
8:45 a. m....	724.4	− 3.2	74	ese.	6.7	516	724.4	− 3.2	74	ese.	6.7
8:59 a. m....	724.4	− 3.2	74	ese.	6.3	707	708.0	− 4.8	......	se.	....
9:46 a. m....	724.6	− 2.8	78	ese.	5.4	814	698.7	− 2.8	......	se.	....
9:55 a. m....	724.7	− 2.8	78	ese.	5.4	710	708.0	− 4.6	......	se.	....
9:58 a. m....	724.7	− 2.8	74	ese.	4.9	526	724.7	− 2.8	74	ese.	4.9
Dec. 14.											
8:36 a. m....	710.4	− 1.2	76	wnw.	8.9	526	710.4	− 1.2	76	wnw.	8.9
8:41 a. m....	710.4	− 1.2	72	wnw.	9.4	924	675.6	− 3.6	......	w.	....
8:47 a. m....	710.4	− 1.2	76	wnw.	8.0	1010	668.2	− 4.7	......	w.	....
8:51 a. m....	710.5	− 1.2	76	wnw.	8.0	1458	631.6	− 2.5	......	wnw.	....
9:02 a. m....	710.6	− 1.1	74	wnw.	8.0	1652	616.4	− 4.5	......	nw.	....
9:16 a. m....	710.7	− 0.9	72	wnw.	6.3	2296	568.5	− 0.5	......	wnw.	....
9:35 a. m....	710.8	− 9.6	70	wnw.	7.6	2892	527.4	− 4.8	......	wnw.	....
9:50 a. m....	710.9	− 0.1	70	wnw.	9.4	3109	513.2	− 4.2	......	wnw.	....
10:11 a. m....	711.1	0.4	68	wnw.	6.3	3983	459.2	− 7.8	......	w.	....
11:35 a. m....	711.3	− 2.1	63	wnw.	5.8	3184	509.5	− 3.8	......	wnw.	....
11:40 a. m....	711.3	2.2	62	wnw.	5.4	3070	517.0	− 4.2	......	wnw.	....
12:06 p. m....	711.2	2.4	62	wnw.	6.3	2369	564.8	0.0	......	wnw.	....
12:16 p. m....	711.1	2 6	62	wnw.	7.6	2018	589.8	− 1.9	......	wnw.	....
12:26 p. m....	711.0	2.8	60	wnw	7.6	1448	633.4	− 0.4	......	wnw.	....
12:34 p. m....	711.0	2.8	60	wnw.	7.6	1315	644.1	− 3.7	......	w.	....
12:42 p. m....	710.9	3.0	58	wnw.	7.6	829	684.6	− 1.1	......	w.	....
12:48 p. m....	710.8	2.7	64	wnw.	5.8	525	710.8	2.7	64	wnw.	5.8
Dec. 15.											
7:39 a. m....	710.4	2.0	71	wnw.	4.9	526	710.4	2.0	71	wnw.	4.9
7:47 a. m....	710.4	2.0	72	wnw.	6.7	919	676.4	− 1.8	......	wnw.	....
8:07 a. m....	710.4	1.4	79	nw.	8.0	1383	637.7	− 5.8	......	wnw.	....
8:50 a. m....	710.8	0.7	72	nw.	10.7	1909	596.4	− 9.2	......	w.	....
8:56 a. m....	710.9	0.6	72	nw.	10.7	2108	581.5	−10.0	......	w.	....
9:02 a. m....	710.9	0.6	76	nw.	8.0	2823	530.3	− 7.2	......	w.	....
9:31 a. m....	711.0	0.5	71	nw.	9.4	3474	488.0	−10.4	......	w.	....
10:37 a. m....	711.3	0.8	66	nw.	9.1	2813	532.2	− 5.7	......	w.	....
11:03 a. m....	711.3	0.7	65	nw.	9.0	2544	550.9	− 5.9	......	w.	....
11:20 a. m....	711.1	1.2	60	nw.	8.9	2382	562.1	− 3.6	......	w.	....
11:45 a. m....	710.9	1.4	60	nw.	12.5	2114	581.5	− 4.8	......	wnw.	....
11:57 a. m....	710.8	1.4	60	nw.	10.3	1940	594.5	− 7.9	......	w.	....
12:06 p. m....	710.8	1.2	62	nw.	10.3	1385	637.7	− 7.1	......	w.	....
12:16 p. m....	710.8	1.1	66	nw.	10.3	878	680.1	− 4.0	......	wnw.	....
12:24 p. m....	710.8	1.0	64	nw.	9.8	526	710.8	1.0	64	nw.	9.8

December 12.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 2000 m.; at maximum altitude, 1200 m.

The sky was covered with St. from the southeast. Light snow fell until 9:23 a. m.

Pressure was high over New York and low over Mississippi.

December 14.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 8000 m., at maximum altitude.

About 7/10 A.-Cu from the west-southwest were present at the beginning. These had disappeared by 11:16 a. m. A few Cu. from the west-northwest appeared at 10:17 a. m. and had increased to 2/10 by 11:16 a. m.

Low pressure was central north of Lake Huron. Relatively high pressure was central over southern Georgia.

December 15.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 8000 m., at maximum altitude.

St.-Cu. from the west covered the sky until 10 a. m., and diminished to 6/10 by the end of the flight. Snow fell from 8:07 to 8:10 a. m. The head kite was hidden by St.-Cu., except at intervals, from 8:06 until 11 a. m.

Low pressure was central over Maine. Pressure was high over the Gulf States and west of the Mississippi.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.											
Dec. 16.	mm.	° C.	%		m. p. s.	Meters.	mm.	° C.	%		m. p. s.
8:20 a. m.	709.3	− 4.1	85	wnw.	13.0	526	709.3	− 4.1	85	wnw.	13.0
8:30 a. m.	709.4	− 4.1	80	wnw.	14.3	904	675.9	− 8.0	......	wnw,	....
9:42 a. m.	710.2	− 4.8	81	nw.	12.1	1450	630.2	−13.6	......	wnw.	....
9:55 a. m.	710.4	− 5.1	84	nw.	13.0	1880	595.9	−10.4	......	wnw.	....
10:25 a. m.	710.4	− 5.0	79	nw.	11.6	2075	581.0	−10.6	......	wnw.	....
10:39 a. m.	710.3	− 5.0	81	nw.	11.6	3150	504.4	−16.6	......	wnw.	....
11:16 a. m.	710.3	− 4.7	77	nw.	12.1	3580	476.2	−19.4	......	wnw.	....
1:01 p. m.	710.2	− 3.2	83	nw.	14.3	3167	504.4	−16.1	......	wnw.	....
1:54 p. m.	710.6	− 2.9	83	nw.	12.5	2095	581.0	−10.6	......	wnw.	....
2:51 p. m.	710.9	− 3.2	70	nw.	11.6	1660	615.0	− 9.6	......	wnw.	....
3:40 p. m.	711.1	− 4.0	67	nw.	11.2	964	672.4	− 7.8	......	nw.	....
3:49 p. m.	711.2	− 4.0	74	nw.	9.4	526	711.2	− 4.0	74	nw.	9.4
Dec. 17.											
7:38 a. m.	714.3	− 1.2	46	sw.	5.4	526	714.3	− 1.2	46	sw.	5.4
7:54 a. m.	714.4	− 1.2	44	sw.	5.4	932	678.8	− 3.6	......	sw.	....
8:06 a. m.	714.4	− 1.1	45	sw.	5.4	1500	631.3	− 7.7	......	wnw.	....
8:17 a. m.	714.4	− 1.0	57	sw.	4.9	2061	587.7	− 9.5	......	wnw.	....
8:29 a. m.	714.4	− 0.5	47	sw.	4.9	2211	576.5	− 6.6	......	w.	....
8:49 a. m.	714.5	− 0.4	49	wsw.	4.5	2691	542.1	−10.0	......	w.	....
9:20 a. m.	714.5	0.3	52	sw.	4.5	3776	470.4	−15.4	......	w.	....
9:47 a. m.	714.4	0.4	46	ssw.	5.4	4331	436.8	−18.9	......	w.	....
11:00 a. m.	713.7	2.2	49	s.	5.8	3661	477.3	−15.8	......	w.	....
11:45 a. m.	713.2	2.8	46	s.	4.5	3108	513.0	−12.8	......	w.	....
12:31 p. m.	712.8	3.6	50	ssw.	4.5	1961	595.1	− 7.0	......	w.	....
12:40 p. m.	712.7	3.6	48	ssw.	4.9	1830	605.0	− 7.0	......	w.	....
12:50 p. m.	712.6	3.5	47	ssw.	5.4	1540	627.7	− 5.7	......	w.	....
12:59 p. m.	712.5	3.6	50	ssw.	4.9	979	673.5	− 0.7	......	w.	....
1:10 p. m.	712.4	4.0	47	ssw.	5.4	526	712.4	4.0	47	ssw.	5.4
Dec. 18.											
8:46 a. m.	712.5	− 7.6	54	wnw.	16.1	526	712.5	− 7.6	54	wnw.	16.1
8:55 a. m.	712.5	− 7.4	52	wnw.	16.1	893	679.6	−10.0	......	wnw.	....
8:59 a. m.	712.5	− 7.2	51	wnw.	16.5	1083	663.1	−10.5	......	nw.	....
9:16 a. m.	712.7	− 7.0	49	wnw.	18.3	1499	628.5	− 9.9	......	nw	....
9:32 a. m.	712.9	− 6.8	49	wnw.	15.6	1958	592.2	−12.9	......	nw.	....
10:20 a. m.	713.3	− 6.1	51	wnw.	12.5	2368	561.6	−12.9	......	nw.	....
10:26 a. m.	713.3	− 6.3	51	wnw.	12.5	2136	579.2	−12.5	......	nw.	....
10:48 a. m.	713.2	− 6.1	54	nw.	16.5	1357	640.9	− 9.0	......	nw.	....
10:58 a. m.	713.2	− 6.1	56	nw.	16.1	1069	665.0	− 7.5	......	nw.	....
11:05 a. m.	713.2	− 5.8	56	nw.	17.4	942	676.1	−10.0	......	nw.	....
11:15 a. m.	713.2	− 6.1	59	nw.	13.9	526	713.2	− 6.1	59	nw.	13.9

December 16.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 7500 m., at maximum altitude.

8/10 to 10/10 St.-Cu., from the west-northwest, prevailed until about noon, and then rapidly diminished to few by 3 p. m. Light snow fell from 9:35 to 10:35 a. m. The head kite was in or above the clouds at intervals between 8:45 a. m. and noon.

At 8 a. m. pressure was high over Texas and Louisiana and low over Minnesota and the Gulf of St. Lawrence.

December 17.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 8000 m.; at maximum altitude, 7800 m.

St.-Cu. from the west-northwest increased from 3/10 at the beginning to 9/10 by 8:32 a. m., and had decreased to a few by 9:44 a. m. The head kite entered the cloud base at an altitude of 1500 m.

Pressure was low over Lake Huron and high over the eastern Gulf States.

December 18.—Three kites were used; lifting surface, 16.2 sq. m. Wire out, 4750 m.; at maximum altitude, 3550 m.

A few Cu. from the northwest were visible.

Pressure was low over Nova Scotia and high over Kansas and Georgia.

RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909.											
Dec. 19.	*mm.*	°*C.*	%		*m. p. s.*	*Meters.*	*mm.*	°*C.*	%		*m. p. s.*
7:47 a. m....	712.7	−11.6	89	nw.	5.4	526	712.7	−11.6	89	nw.	5.4
7:58 a. m....	712.7	−11.4	86	nw.	5.4	811	686.7	−12.6	......	wnw.	....
8:20 a. m....	712.7	−11.3	86	nw.	5.4	1020	668.3	− 8.2	......	wnw.	....
9:00 a. m....	712.8	−10.6	86	nw.	4.9	1553	623.9	− 9.3	......	wnw.	....
9:25 a. m....	712.9	−10.0	78	nw.	4.9	2816	529.4	−13.5	......	w.	....
9:50 a. m....	713.0	− 9.8	75	nw.	4.9	3419	489.0	−15.5	......	w.	....
10:16 a. m....	713.0	− 9.4	76	nw.	8.0	526	713.0	− 9.4	76	nw.	8.0
Dec. 20.											
9:37 a. m....	714.7	− 9.8	80	nw.	9.8	526	714.7	− 9.8	80	nw.	9.8
9:46 a. m....	714.8	− 9.6	80	nw.	8.5	882	682.5	−13.2	......	wnw	....
9:55 a. m....	714.9	− 9.4	77	nw.	8.5	1320	644.7	− 9.3	......	wnw.	....
10:05 a. m....	714.9	− 9.2	75	nw.	8.5	1812	604.9	− 9.2	......	wnw.	....
10:30 a. m....	714.8	− 8.5	74	wnw.	8.9	2502	553.0	−13.0	......	w.	....
11:05 a. m....	714.7	− 8.0	62	nw.	4.9	3068	513.1	−16.0	......	w.	....
11:48 a. m....	714.5	− 8.1	68	wnw.	6.3	2602	545.2	−13.9	......	w.	....
12:00 m......	714.4	− 7.4	62	wnw.	5.8	2240	571.7	−11.5	......	wnw.	....
12:07 p. m....	714.3	− 7.0	62	wnw.	5.4	1502	629.0	− 8.8	......	wnw.	....
12:27 p. m....	714.1	− 6.9	59	wnw.	6.7	1157	657.7	−14.2	......	wnw.	....
12:33 p. m....	714.1	− 6.9	59	wnw.	5.8	790	690.1	−11.1	......	wnw.	....
12:37 p. m....	714.1	− 6.8	56	wnw.	5.8	526	714.1	− 6.8	56	wnw.	5.8
Dec. 21.											
7:40 a. m....	716.9	− 8.6	70	w.	4.9	526	716.9	− 8.6	70	w.	4.9
7:58 a. m....	716.9	− 8.4	71	wsw.	4.0	860	686.7	−10.0	......	w.	....
8:14 a. m....	716.9	− 7.8	71	wsw.	4.9	1301	648.1	−12.4	......	wnw.	....
8:33 a. m....	716.9	− 7.4	65	wsw.	5.4	1733	612.9	−11.5	......	wnw.	....
8:40 a. m....	716.9	− 7.2	65	wsw.	5.8	1953	595.6	− 9.7	......	wnw.	....
9:00 a. m....	716.9	− 7.1	62	wsw.	5.8	2540	551.9	−11.4	......	wnw.	....
9:36 a. m....	717.0	− 6.2	59	wsw.	6.3	3470	489.0	−11.1	......	w.	....
9:44 a. m....	717.0	− 6.1	59	wsw.	6.7	3390	494.7	−11.9	......	w.	....
10:22 a. m....	717.0	− 5.2	62	wsw.	5.4	2843	531.4	−11.8	......	w.	....
11:12 a. m....	716.8	− 4.3	57	wsw.	6.7	1651	620.3	− 9.0	......	w.	....
11:27 a. m....	716.7	− 3.6	56	wsw.	5.8	1378	642.5	−10.6	......	w.	....
11:40 a. m....	716.6	− 3.8	57	wsw.	6.3	797	692.3	− 8.0	......	wsw.	....
11:46 a. m....	716.6	− 3.5	54	w.	6.3	526	716.6	− 3.5	54	w.	6.3

December 19.—Four kites were used; lifting surface, 21,6 sq. m. Wire out, 7000 m.; at maximum altitude, 6900 m.

About 7/10 clouds were visible, consisting of A.-St. from the west until 9 a. m., and A.-St. and Ci.-St. from the same direction thereafter.

Pressure was low over the Gulf of St. Lawrence and Florida and high over southern Illinois.

December 20.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 4500 m.; at maximum altitude, 4250 m.

Ci.-Cu. and A.-St., from the west, covered 8/10 of the sky until 11:30 a. m., and diminished to 3/10 by the end of the flight.

High pressure covered practically all of the United States, except the Lake region and New England.

December 21.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 5000 m.; at maximum altitude, 4800 m.

A few A.-St. were visible near the horizon before 8:40 a. m.

Pressure was low over the Gulf of St. Lawrence and high over Kansas.

RESULTS OF KITE FLIGHTS.

Date and hour.	At Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909. Dec. 22.	mm.	° C.	%		m. p. s.	Meters.	mm.	° C.	%		m. p. s.
8:43 a. m.	712.2	− 6.4	68	nw.	16.1	526	712.2	− 6.4	68	nw.	16.1
8:52 a. m.	712.3	− 6.5	66	wnw.	16.1	859	682.4	−10.5	......	nw.	....
9:09 a. m.	712.3	− 7.1	78	nw.	14.8	1196	653.0	−12.7	......	nw.	....
9:23 a. m.	712.4	− 7.6	77	nw.	14.8	1572	621.6	−15.1	......	wnw.	....
9:36 a. m.	712.5	− 7.9	74	nw.	15.2	1879	596.9	−17.0	......	wnw.	....
10:20 a. m.	712.9	− 8.0	63	nw.	13.4	2813	527.1	−18.5	......	wnw.	....
10:43 a. m.	713.2	− 7.8	60	nw.	17.9	526	713.2	− 7.8	60	nw.	17.9
Dec. 23.											
3:49 p. m.	719.4	− 2.7	87	wnw.	17.9	526	719.4	− 2.7	87	wnw.	17.9
4:07 p. m.	719.4	− 2.8	80	wnw.	13.4	1249	655.9	− 9.1	......	nw.	....
4:18 p. m.	719.3	− 3.0	74	wnw.	15.2	1610	626.3	− 4.6	......	nw.	....
4:29 p. m.	719.3	− 3.2	76	wnw.	16.1	1869	605.9	− 5.6	......	nw.	....
5:23 p. m.	719.0	− 3.9	80	wnw.	18.8	1266	654.1	− 2.5	......	nw.	....
5:32 p. m.	719.0	− 4.0	77	wnw.	18.8	1027	674.4	− 8.7	......	wnw.	....
6:00 p. m.	718.9	− 4.2	77	wnw.	21.5	526	718.9	− 4.2	77	wnw.	21.5
Dec. 24.											
10:27 a. m.	719.5	− 3.0	57	nw.	15.6	526	719.5	− 3.0	57	nw.	15.6
10:32 a. m.	719.4	− 2.8	57	nw.	13.4	918	684.6	− 5.0	......	nw.	....
10:48 a. m.	719.3	− 2.7	53	nw.	11.6	1400	644.0	− 1.5	......	nnw.	....
11:13 a. m.	719.1	− 2.4	53	nw.	15.2	1555	631.5	0.0	......	nnw.	....
11:20 a. m.	719.1	− 2.3	53	nw.	17.0	2176	584.1	− 3.4	......	nnw.	....
11:42 a. m.	718.7	− 1.9	53	nw.	14.3	2868	534.8	− 6.0	......	nnw.	....
12:32 p. m.	718.4	− 1.3	43	nw.	11.2	2093	589.7	− 3.4	......	nnw.	....
12:55 p. m.	718.3	− 0.7	43	nw.	11.6	1483	636.6	0.0	......	nnw.	....
1:16 p. m.	718.2	− 0.4	43	nw.	8.9	954	680.8	− 5.5	......	nw.	....
1:28 p. m.	718.2	− 0.4	43	nw.	11.6	526	718.2	− 0.4	43	nw.	11.6
Dec. 25.											
10:54 a. m.	704.8	− 3.2	100	sse.	8.0	526	704.8	− 3.2	100	sse.	8.0
11:04 a. m.	704.5	− 3.2	100	sse.	7.2	766	683.4	− 4.3	......	s.	....
11:15 a. m.	704.1	− 3.2	100	sse.	6.7	978	665.0	− 3.0	......	s.	....
11:32 a. m.	703.6	− 3.2	100	sse.	6.3	1195	646.5	− 1.0	......	s.	....
11:46 a. m.	703.1	− 3.2	100	sse.	5.8	878	672.4	− 4.6	......	s.	....
11:56 a. m.	702.8	− 3.2	100	sse.	6.7	526	702.8	− 3.2	100	sse.	6.7

December 22.—Three kites were used; lifting surface, 16.2 sq. m. Wire out, 5600 m.; at maximum altitude, 5400 m.

The sky was nearly overcast throughout the flight; at the beginning with St.-Cu. from the west-northwest and St. from the northwest, after 10 a. m. with St.-Cu. from the west-northwest. The head kite entered the St. at an altitude of about 1200 m. Light snow fell from 8:56 a. m. to 9:43 a. m.

Pressure was low over Newfoundland and high over Kansas.

December 23.—One kite was used; lifting surface, 5.4 sq. m. Wire out, 3000 m., at maximum altitude.

St.-Cu., from the northwest, varied from 7/10 to 9/10.

At 8 a. m. high pressure was central over the middle Mississippi Valley and low pressure over the Gulf of St. Lawrence.

December 24.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 4000 m., at maximum altitude.

A few Ci.-Cu. were visible near the horizon after 11:38 a. m.

Pressure was high over the Ohio Valley and low over Nova Scotia.

December 25.—One kite was used; lifting surface, 5.4 sq. m. Wire out, 1800 m.; at maximum altitude, 1500 m.

Snow and dense fog prevailed throughout the flight.

At 8 a. m. an energetic low was central over Indiana.

RESULTS GF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.	Height.	Air pres.	Air temp.	Rel. hum.	Wind. Dir.	Wind. Velocity.
1909. Dec. 28.	mm.	° C.	%		m. p. s.	Meters.	mm.	° C.	%		m. p. s.
9:30 a. m....	706.5	− 5.4	70	wnw.	7.6	526	706.5	− 5.4	70	wnw.	7.6
9:39 a. m....	706.5	− 5.4	70	wnw.	7.2	870	676.0	− 8.4	......	w.	....
10:16 a. m....	706.5	− 4.9	66	w.	7.6	1790	600.3	−11.7	......	w.	....
11:20 a. m....	706.2	− 4.2	62	wnw.	9.8	2440	550.5	−17.7	......	w.	....
11:42 a. m....	706.0	− 4.1	61	wnw.	8.9	2803	524.3	−19.8	......	w.	....
11:45 a. m....	706.0	− 3.9	62	w.	8.9	3261	493.2	−17.9	......	w.	....
11:50 a. m....	706.0	− 3.8	59	wnw.	8.9	3614	469.4	−18.8	......	w.	....
12:08 p. m....	705.9	− 3.7	59	wnw.	7.6	3559	473.2	−18.2	......	w.	....
12:22 p. m....	705.9	− 3.5	60	wnw.	7.6	3279	491.3	−21.1	......	w.	....
12:56 p. m....	705.8	− 3.4	61	w.	7.2	2699	531.8	−19.0	......	wsw.	....
1:32 p. m....	705.7	− 3.5	59	wnw.	6.3	1832	596.0	−14.8	......	wsw.	....
1:48 p. m....	705.7	− 3.6	60	wnw.	4.9	1298	639.1	−11.2	......	w.	....
1:59 p. m....	705.7	− 3.6	61	wnw.	7.2	863	676.0	− 7.4	......	wnw.	....
2:07 p. m....	705.8	− 3.6	65	wnw.	7.6	526	705.8	− 3.6	65	wnw.	7.6
Dec. 29.											
10:57 a. m....	704.7	− 9.8	67	nw.	16.1	526	704.7	− 9.8	67	nw.	16.1
11:15 a. m....	704.7	−10.0	67	wnw.	17.9	1016	660.9	−14.2	......	wnw.	....
11:29 a. m....	704.7	− 9.6	68	nw.	17.0	1102	653.5	−13.2	......	nw.	....
11:58 a. m....	704.6	− 9.5	68	nw.	15.6	1475	622.1	−15.7	......	nw.	....
12:20 p. m....	704.5	− 9.4	61	nw.	17.0	1295	636.9	−14.9	......	nw.	....
12:36 p. m....	704.4	− 9.2	62	nw.	17.9	1252	640.5	−15.5	......	nw.	....
1:09 p. m....	704.4	− 8.6	60	wnw.	17.0	846	675.7	−12.2	......	wnw.	....
1:18 p. m....	704.6	− 8.8	67	wnw.	15.2	526	704.6	− 8.8	67	wnw.	15.2
Dec. 30.											
2:04 p. m....	714.9	−11.4	64	wnw.	14.8	526	714.9	−11.4	64	wnw.	14.8
2:14 p. m....	715.0	−11.3	64	wnw.	13.4	868	683.6	−14.6	......	wnw.	....
2:30 p. m....	715.1	−11.0	64	wnw.	13.4	1160	657.9	−17.1	......	wnw.	....
3:03 p. m....	715.3	−11.2	64	wnw.	12.5	1397	637.6	−18.3	......	wnw.	....
3:11 p. m....	715.3	−11.1	64	wnw.	12.5	1642	617.2	−15.7	......	wnw.	....
3:20 p. m....	715.3	−11.2	57	wnw.	10.7	1901	596.2	−15.6	......	wnw.	....
3:39 p. m....	715.4	−11.5	60	wnw.	11.6	1551	624.6	−15.7	......	wnw.	....
3:52 p. m....	715.4	−11.6	62	wnw.	11.6	1309	645.0	−18.9	......	wnw.	....
4:02 p. m....	715.4	−11.6	62	wnw.	12.5	1014	670.8	−16.6	......	wnw.	....
4:14 p. m....	715.3	−11.8	62	wnw.	15.6	809	689.2	−15.2	......	wnw.	....
4:24 p. m....	715.3	−12.0	62	wnw.	15.6	526	715.3	−12.0	62	wnw.	15.6

December 28.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5200 m.; at maximum altitude, 5150 m.

The sky was from 4/10 to 10/10 obscured throughout the flight; in the morning by Ci.-Cu. and A.-Cu. from the west, and in the afternoon by Ci.-Cu. from the west and St. from the west-southwest. The altitude of the St. was about 2000 m. Light snow fell from 1:26 to 1:45 p. m.

Pressure was low over the Lake region and off the middle Atlantic coast and high over Manitoba, Texas, and Western States.

December 29.—Two kites were used; lifting surface, 8.7 sq. m. Wire out, 3000 m.; at maximum altitude, 2800 m.

About 6/10 Ci.-St. and 1/10 St.-Cu., from the northwest were observed.

Pressure was low over the Atlantic States and high west of the Appalachian Mountains.

December 30.—Three kites were used; lifting surface, 12.4 sq. m. Wire out, 3000 m., at maximum altitude.

A few to 3/10 St. from the west-northwest were visible. Ci.-Cu. from the west increased from a few at 2:38 to 6/10 at the close of the flight.

Pressure was high over Alabama and low off the coast of Nova Scotia.

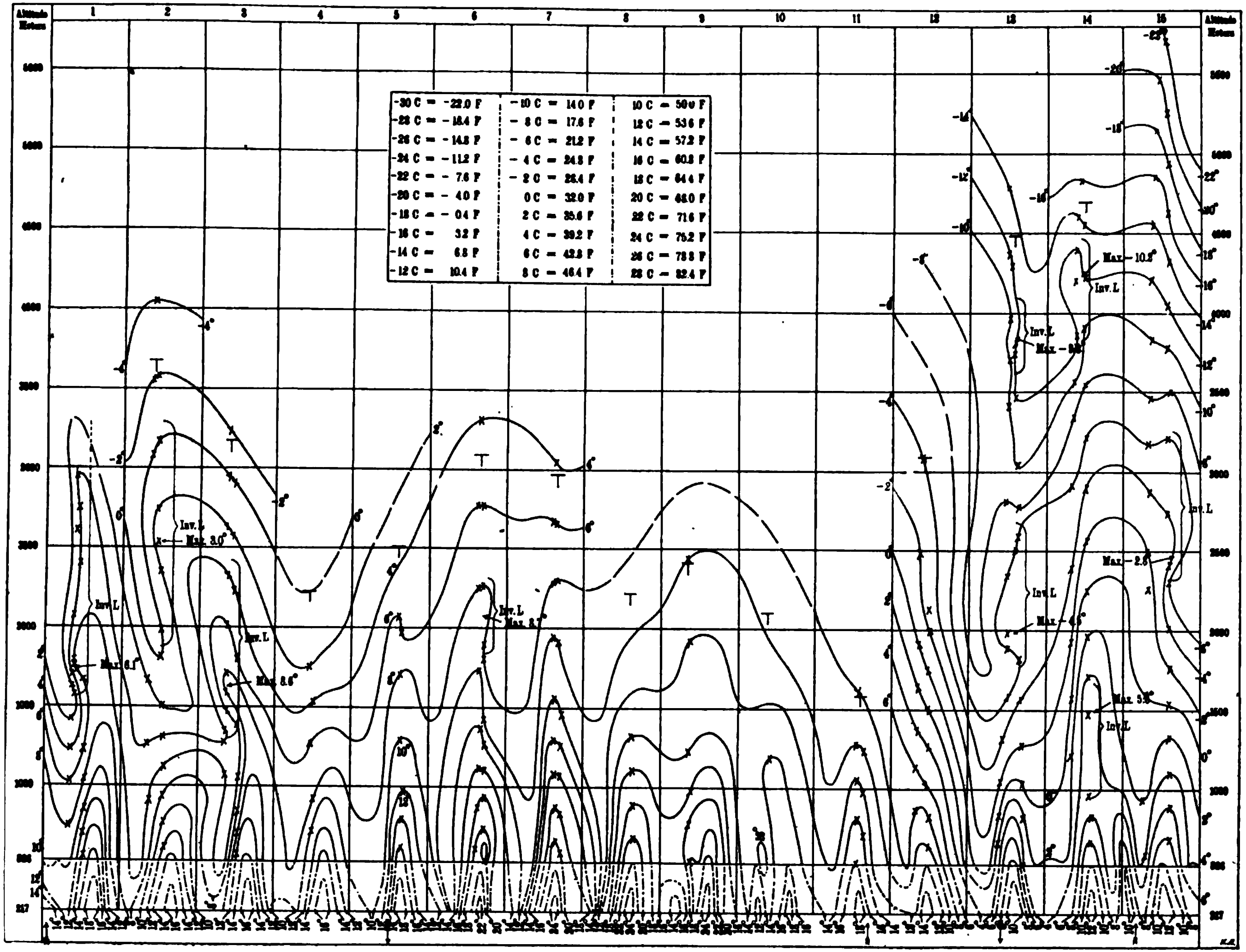
RESULTS OF KITE FLIGHTS.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Air pres.	Air temp.	Rel. hum.	Wind.		Height.	Air pres.	Air temp.	Rel. hum.	Wind.	
				Dir.	Velocity.					Dir.	Velocity.
1909. Dec. 31.	*mm.*	*° C.*	*%*		*m. p. s.*	*Meters.*	*mm.*	*° C.*	*%*		*m. p. s.*
4:11 p. m....	717.8	− 7.3	64	se.	3.1	526	717.8	− 7.3	64	se.	3.1
5:14 p. m....	718.3	− 7.7	70	se.	4.5	748	698.2	− 6.0	......	ssw.	....
6:00 p. m....	718.5	− 7.0	64	se.	4.5	982	677.8	− 7.6	......	sw.	....
6:05 p. m....	718.5	− 7.1	67	se.	4.0	1397	642.8	− 4.7	......	w.	....
6:20 p. m....	718.6	− 7.0	64	se.	4.0	1088	668.7	− 7.3	......	sw.	....
6:29 p. m....	718.6	− 7.0	63	se.	3.6	856	688.9	− 6.0	......	sw.	....
6:37 p. m....	718.7	− 7.2	69	se.	4.0	526	718.7	− 7.2	69	se.	4.0

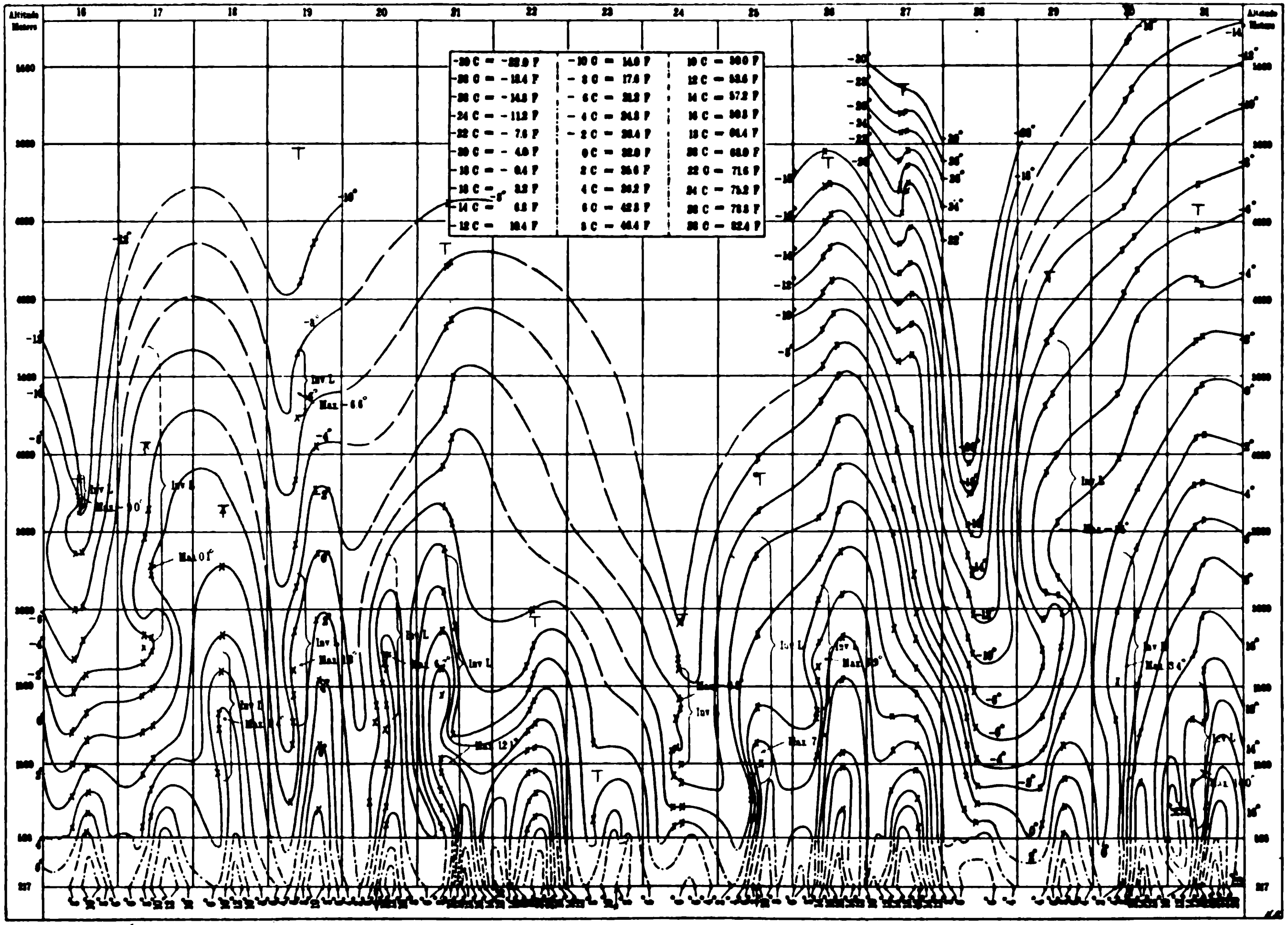
December 31.—Three kites were used; lifting surface, 19.4 sq. m. Wire out, 1700 m.; at maximum altitude, 1150 m.

About 7/10 A.-Cu. from the northwest were present.

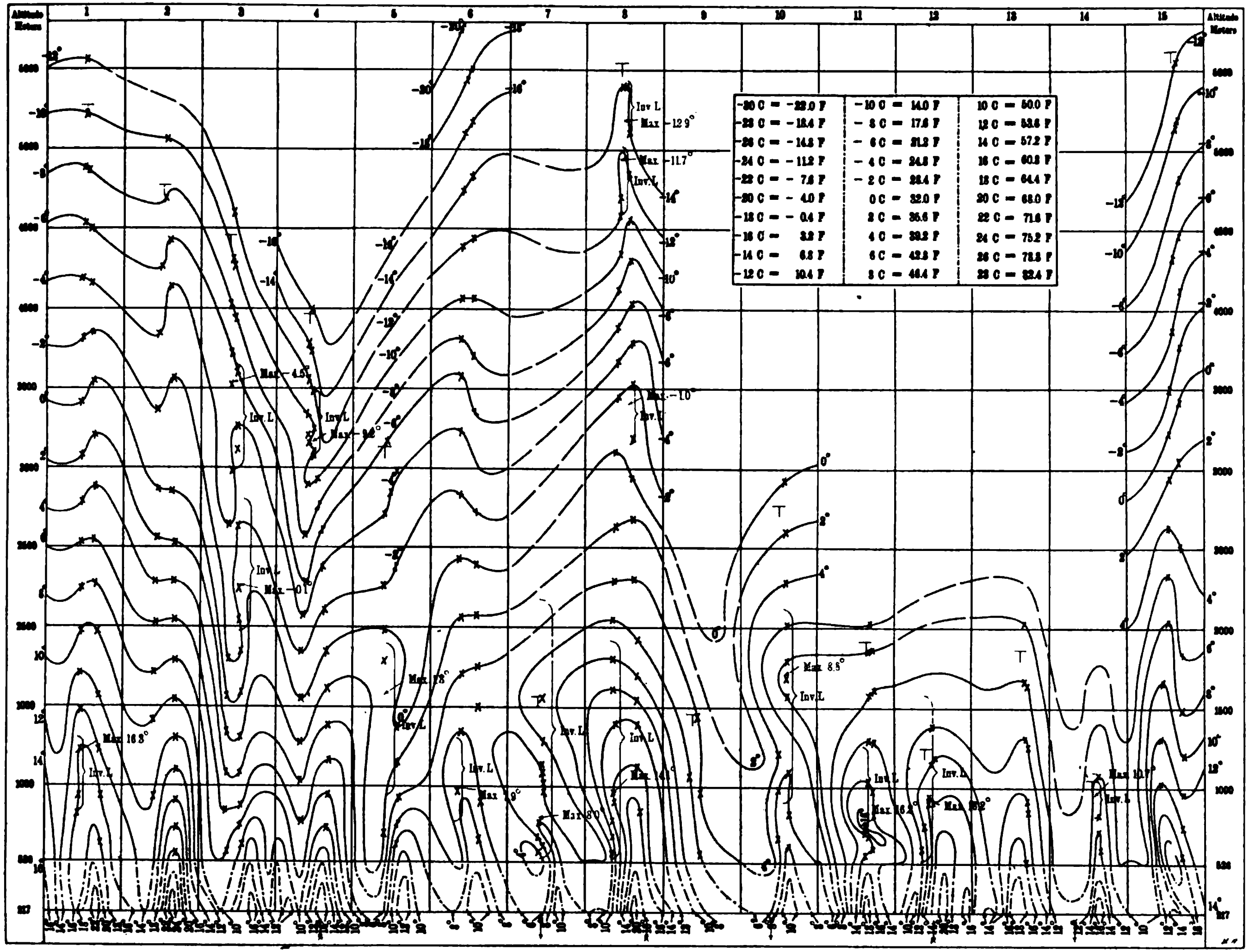
Pressure was low over the Gulf of St. Lawrence and high over Florida.



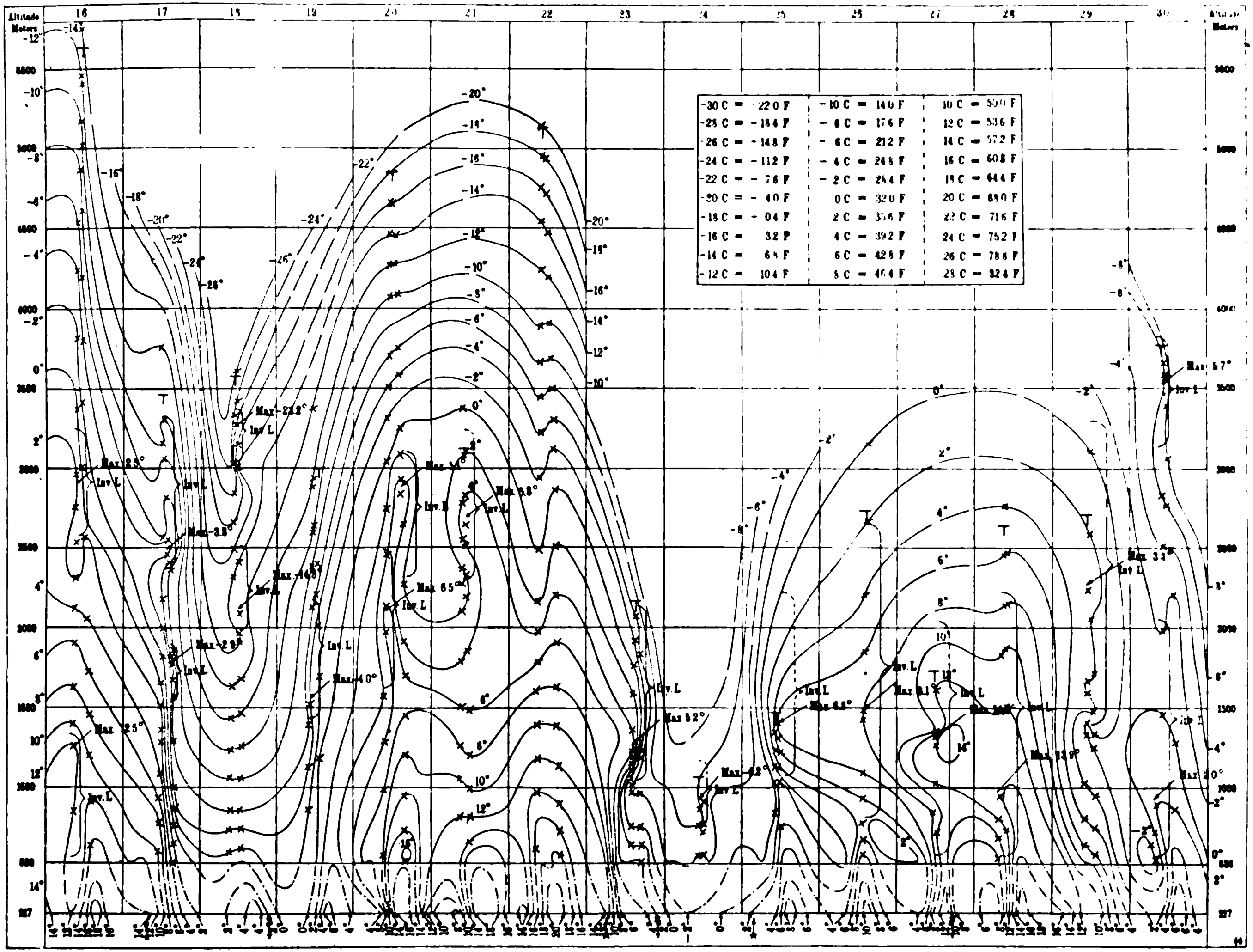
Upper air isotherms, October 1–15, 1909.



Upper air isotherms, October 16–31, 1909.

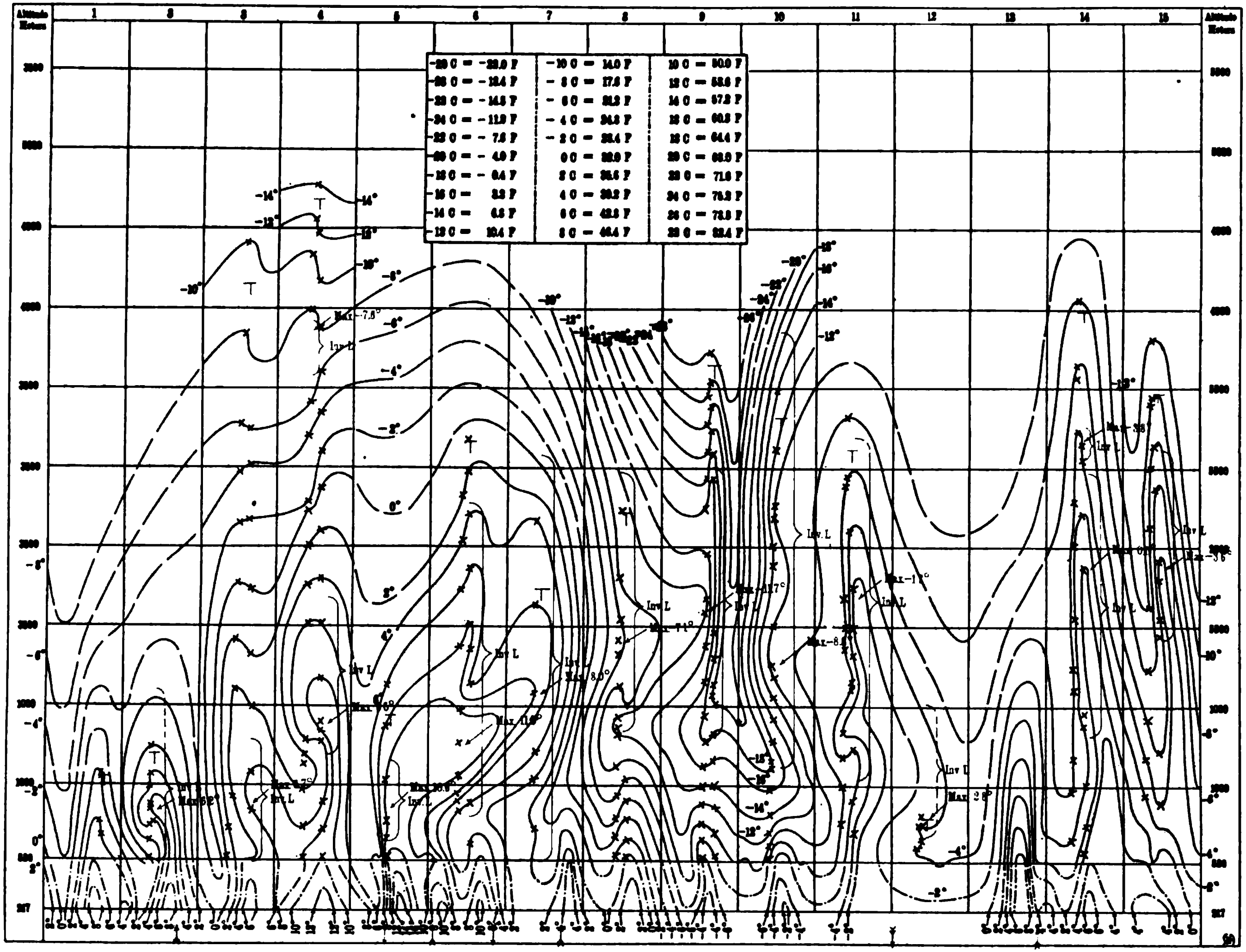


Upper air isotherms, November 1–15, 1909.

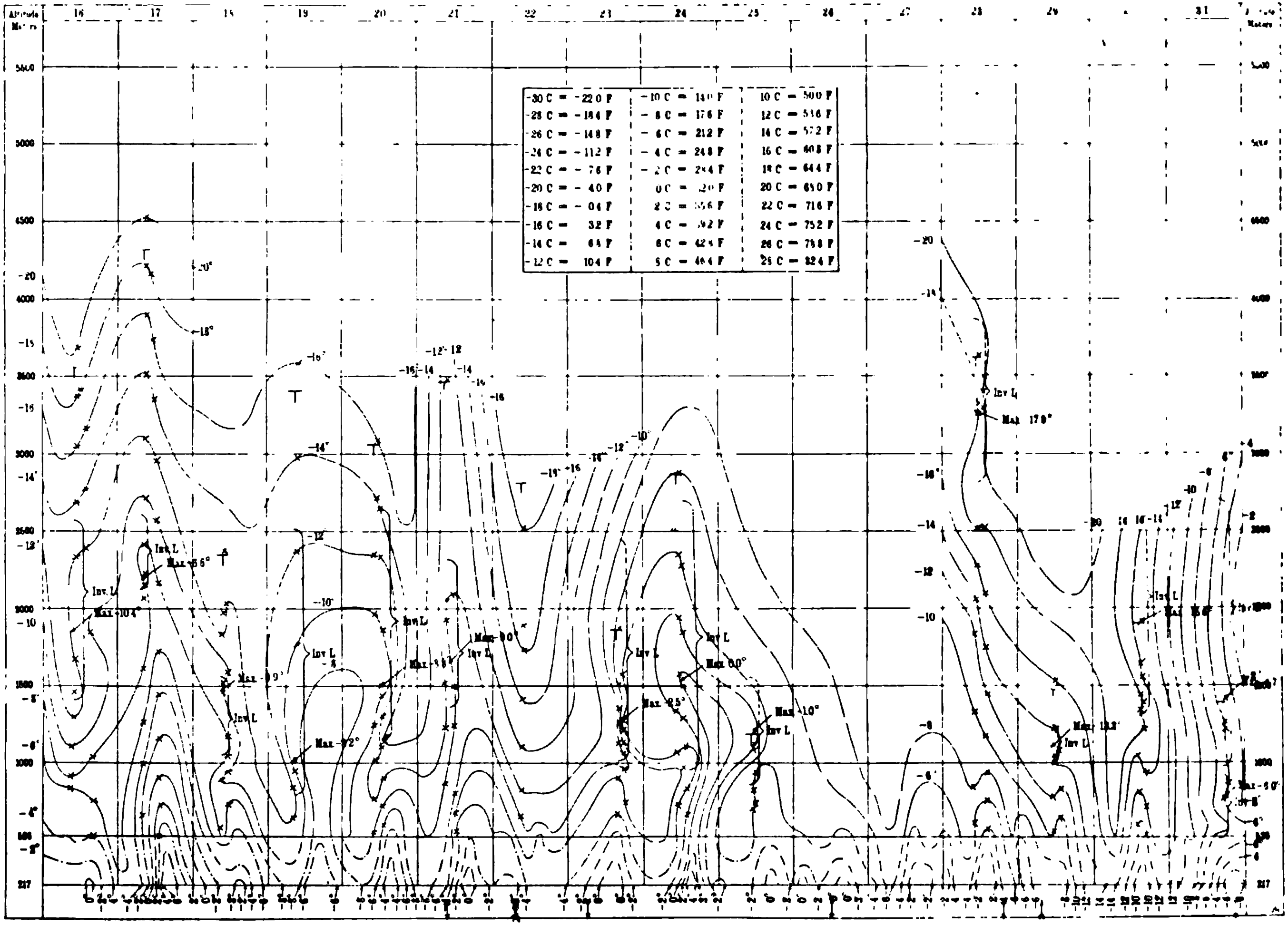


-30 C = -22.0 F	-10 C = 14.0 F	10 C = 50.0 F
-28 C = -18.4 F	-8 C = 17.6 F	12 C = 53.6 F
-26 C = -14.8 F	-6 C = 21.2 F	14 C = 57.2 F
-24 C = -11.2 F	-4 C = 24.8 F	16 C = 60.8 F
-22 C = -7.6 F	-2 C = 28.4 F	18 C = 64.4 F
-20 C = -4.0 F	0 C = 32.0 F	20 C = 68.0 F
-18 C = -0.4 F	2 C = 35.6 F	22 C = 71.6 F
-16 C = 3.2 F	4 C = 39.2 F	24 C = 75.2 F
-14 C = 6.8 F	6 C = 42.8 F	26 C = 78.8 F
-12 C = 10.4 F	8 C = 46.4 F	28 C = 82.4 F

Upper air isotherms, November 16–30, 1909.



Upper air isotherms, December 1–15, 1909.



Upper air isotherms, December 16–31, 1909.

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